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DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SPECIFICATION

ARTS IIIA IMPROVEMENTS TO THE MODULARLY EXPANDABLE

ARTS III BEACON TRACKING LEVEL SYSTEM

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION SPECIFICATION

SPECIFICATION FOR ARTS IIIA IMPROVEMENTS TO THE MODULARLY EXPANDABLE ARTS III BEACON TRACKING LEVEL SYSTEM

1. INTRODUCTION - This system specification describes the requirements for enhancing the existing Modular Automated Radar Terminal System (ARTS). This enhancement is an initial set of improvements which will meet immediate terminal air traffic control needs. It also affords the broader automation base required for the addition of automation enhancements necessary to meet future operational requirements.

1.1 Scope - Existing (basic) ARTS III systems are essentially beacon tracking level systems, i.e., they process and track secondary radar (beacon) data derived from up to two ASR systems. These data are processed, tracked and displayed on a CRT in association with automatically and semiautomatically displayed symbology and alphanumerics. The latter provides aircraft identification, Mode C derived altitude, target velocity and/or radar beacon code readout to the operator (Air Traffic Controller). The system permits the operator to enter data and selectively display, alter or delete data consistent with operational needs. Normal primary as well as secondary radar presentations are displayed concurrently with the symbolic and alphanumeric data. The system also provides the capability of data/message interchange with ARTCC computer systems. Basic ARTS III systems are equipped with a magnetic tape subsystem used principally for loading the software program and a teletypewriter subsystem primarily used for on-line printing of system status messages.

The purpose of this enhancement is to elevate a number of Beacon Tracking Level Systems (BTL) to Radar and Beacon Tracking Level Systems (RT&BTL) ARTS IIIA. In

addition, it is to add Continuous Data Recording (CDR) capability to all ARTS III systems. As a minimum, the added improvements are to provide:

(a) Processing, tracking and display of all primary and secondary radar video from one or more ASR systems.

(b) Improved quality and performance of the existing ARTS III tracking capability by the acquisition and display of all radar derived (primary and beacon) aircraft targets.

(c) Improved fault detection and isolation.

(d) Capability for continued automation operation at levels consistent with system availability when one or more system elements have failed.

(e) Capability for continuous recording of input, output and system status data.

(f) Capability for further functional growth and increased capacity.

(g) Capability for twenty-four hour daily operation in support of operational requirements.

(h) Capability for further modular expansion of hardware and software.

This specification and referenced documents in Section 2 provide the minimum requirements for the design, manufacturing and testing of the data processing subsystems and all the ancillary equipments necessary to interface with the Government Furnished Equipment, in order to provide a fully integrated and operating system.

Software programs in the form of operational programs, utility and support programs, maintenance and diagnostic programs and system test programs are also specified.

2. APPLICABLE DOCUMENTS

2.1 Government Documents - The following documents, including all revisions and amendments, in effect on the date of request for proposal, form a part of this document and are applicable to the extent specified herein.

2.1.1 FAA Specifications -

FAA-TD/S-120-801A	Specification for Modularly Expandable ARTS III (TRACON "C") Beacon Tracking Level System and Spec Changes 1, 2, 3, 4, 5, and 6
FAA-G-1210	Identification & Cataloging of Replaceable Parts
FAA-C-1217	Electrical Work, Interior
FAA-G-2100/*	Part 1, General Requirements for all Equipment
FAA-G-2100/1	Supplement 1c
FAA-G-2100/1	Amendment 2
FAA-G-2100/2	Requirements for Equipments Employing Electron Tubes
FAA-G-2100/3	Requirements for Equipments Employing Semiconductors
FAA-G-2100/4	Requirements for Equipment Employing Printed Wiring

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*Specifications FAA-G-2100/1, Supplement 1c, Amendment 3, FAA-G-2100/2, FAA-G-2100/3, FAA-G-2100/4 and FAA-G-2100/5 are referred to hereafter as FAA-G-2100.

FAA-G-2100/5	Requirements for Equipments Employing Microelectronic Devices
FAA-D-2494/1a	Instruction Book Manuscripts Technical: Equipment and Systems Requirements, Part 1, Preparation of Manuscript
FAA-D-2494/2a	Instruction Book Manuscript Technical: Equipment and Systems Requirements, Part 2, Preparation of Manuscript Copy and Reproducible Artwork
FAA-D-2494/3	Instruction Book Manuscript Technical: Equipment and Systems Requirements, Part 3, Printing Instructions
FAA-E-2591a	Automation Equipment, General Hardware Requirements for Automated Air Traffic System

2.1.2 FAA Standards -

FAA-STD-002	Engineering Drawings
FAA-STD-010a	Graphic Symbols for Digital Logic Diagrams
FAA-STD-013a	Quality Control Program Requirements

2.1.3 FAA Publications -

FAA-SMP-6040.1	Facility Outage and Equipment Failure Report
NAS-MD-601	Interface Control Document
NAS-MD-602	ARTS III System Shakedown
NAS-MD-603	Joint Acceptance Inspection

NAS-MD-604	Introduction to Specification Series
NAS-MD-605	Executive Control
NAS-MD-606	Beacon Message Processing
NAS-MD-607	Beacon Target Processing (Tracking)
NAS-MD-608	Keyboard Input Processing
NAS-MD-609	Display Output Processing
NAS-MD-610	Interfacility Data Transfer
NAS-MD-611	Bulk Store Flight Plans
NAS-MD-612	ASR-37 Error and Status Messages
NAS-MD-613	Adaptation
AO-6030.36A	Maintenance Logs

2.1.4 FAA Instruction Books -

2.1.4.1 Beacon -

(a) Air Traffic Control Beacon Ground Station, Model ATCBI-3, Transmitter Site Equipment Group

(b) Instruction Book Addendum for Air Traffic Control Beacon Ground Station, Model ATCBI-3B

(c) Air Traffic Control Beacon Ground Station, Model ATCBI-3, Indicator Site Equipment Group

(d) Air Traffic Control Beacon Station, Model ATCBI-2, Indicator Site Equipment Group

(e) Beacon Video Defruiting Equipment (Storage Tube) Type FA-7281

(f) Radar Beacon Test Set, Type FA-7270 and Type 7274

(g) Air Traffic Control Beacon Station ATCBI-4, TI 6360.12

(h) Interference Blanker MX-8737/UPX. Technical Manual TM/NAVELEX 0967-426-5010

(i) ATCRBS I/R site test set, FA-8169, TI 6360.11A

2.1.4.2 FAA Directives -

AF P 6350	Radar Microwave Link - RML
AF P 6360.1	ATCBI - Beacon
AF P 6310	ASR - Radar

2.1.4.3 Microwave Link Equipment -

(a) Radar Microwave Link System, RML-2

(b) Radar Microwave Link System, RML-3

(c) Radar Microwave Link System, RML-4

(d) Radar Microwave Link System, RML-1A

(e) Radar Microwave System, RML-5

(f) Radar Microwave System, RML-6 TI 6350.1A

2.1.4.4 Airport Surveillance Radar -

(a) Airport Surveillance Radar, ASR-3

(b) Equipment Modification Set for Airport Surveillance Radar, Model ASR-3 i

(c) Airport Surveillance Radar Antenna System ASR-1, -2, -3, Type FA-5144

(d) Airport Surveillance Radar, ASR-3B

Improvement Instructions

(e) Airport Surveillance Radar, ASR-4, Type FA-4700

(f) Airport Surveillance Radar, ASR-5 (AN/FPN-47), Type FA-4900

(g) Airport Surveillance Radar, ASR-6, Type FA-5900 (ASR-6 uses FA-1544 antenna)

(h) Airport Surveillance Radar Display System (ASRDS) Type FA-7300

(i) Airport Surveillance Radar Display System (ASRDS-2), Type FA-7700

(j) Airport Surveillance Radar Display System (ASRDS-3)

(k) Instruction Book ASR-7, TI 6310.4A

2.1.5 Military Specifications - The following military publication, in effect on the dat of invitation for bids or request for proposals, form a part of this specification:

MIL-I-45208	Inspection System Requirements

2.1.6 Military Standards -

MIL-STD-470	Maintainability Program Requirements for Systems and Equipments, 3/21/66
MIL-STD-471	Maintainability Demonstration
MIL-STD-721B	Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors, and Safety
MIL-STD-781	Reliability Tests, Exponential Distribution

MIL-STD-785 Requirements for Reliability Program

2.2 ARTS III Enhancement Documents - The following documents contain design data and information representing the initial design approach for the Package I improvements. This design approach, both hardware and software, shall be used unless it is proved by the contractor that the design approach cannot meet the requirements set forth in this specification.

(a) Support Software Users' Guide, PX-6196

(b) IOP Multiprocessing Modification Design Data, PX-6361

(c) Design Specification for Display Buffer Memory Module, PX-7978.

(d) Design Specification for Data Recording and Analysis System, PX-10091.

(e) Design Specification for Augmented Radar/Beacon Tracking Level System, PX-7981.

(f) Fail Soft Multiprocessor Executive Program Design Data, PX-7982.

(g) Multiprocessor Executive Model Support, PX-10001

(h) Off-line Diagnostic Design Data, PX-10004.

2.3 Precedence of Documents - When the requirements of the contract schedule, this document, or subsidiary applicable documents are in conflict, the following precedence shall apply. The contract schedule shall have precedence over all other documents. This document shall have precedence over all subsidiary applicable documents referenced herein.

2.3.1 Sources of FAA Documents - Copies of this specification and of the applicable FAA Specification Drawings may be obtained from the Federal Aviation

Administration, Washington, D. C., 20591, attention: Contracting Officer. Requests shall fully identify material desired, i.e., specification numbers, dates, amendment numbers, complete drawing numbers; also, requests should identify the invitation for bids, request for proposals, or the contract involved or other use to be made of the material requested.

2.3.2 Sources of Military Documents - Single copies of military specifications may be obtained from the Federal Aviation Administration, Washington, D. C., 20591, attention: Contracting Officer; mail requests should cite the invitation for bids, request for proposals, or contract for which the specifications are needed; mail requests, if found acceptable, will be forwarded to a military supply depot for filling, hence ample time should be allowed.

2.3.3 Sources of Other Documents - Information on obtaining copies of Federal Specifications and Standards may be obtained from the General Services Administration Offices in Washington, D. C., Seattle, San Francisco, Kansas City, Missouri, Chicago, Atlanta, New York, Boston, Dallas and Los Angeles.

3. SYSTEM REQUIREMENTS

3.1 System Overview - This specification sets forth the minimum requirements for initial improvement of the existing FAA ARTS III systems. These requirements include the system hardware, software, operation, testing, reliability, installation and maintainability functions necessary to enhance ARTS III Beacon Tracking Level (BTL) systems to Radar Tracking and Beacon Tracking (RT & BTL) systems and to provide Continuous Data Recording (CDR) MSAW and Ancilliary Function Capabilities. The system shall provide broadband video on display consoles together with high quality symbolic and alphanumeric characters. These are used for displaying data in tabular lists and for data tags which are associated with displayed aircraft position symbols. Alphanumeric data tags shall be capable of displaying up to three lines of at least seven characters each.

3.1.1 Operation - The system shall track radar and beacon targets and display alphanumerics on a time-shared radar display. It shall consist of ARTS III Government Furnished Equipment (GFE) and contractor supplied hardware, software and system modifications. The design shall provide for 24 hour daily operational capability and also be capable of modular expansion to accommodate future growth. Certain optional functions may be included in the initial contract if so stated therein, or may be ordered later necessitating field installation after the system is in operation. All modifications or additions to the existing system or changes to existing equipment shall be accomplished with minimum disruption to ongoing ARTS III operational priorities and no disruption to broadband radar operational requirements. The system shall meet the performance and overall requirements specified herein.

3.1.2 Hardware - ARTS IIIA hardware shall include four major subsystems:

(a) Data Acquisition Subsystem (DAS)

(b) Data Processing Subsystem (DPS)

(c) Data Entry and Display Subsystem (DEDS)

(d) Continuous Data Recording Subsystem (CDRS)

Each subsystem shall be designed and built so as to permit reasonable system expansion to accommodate potential increases in air traffic control requirements over the next 10 years. For example, the capability for increasing functional performance through field modifications or the addition of equipment and/or software modules.

3.1.3 Software - ARTS IIIA software shall consist of operational programs, utility programs (e.g., assembler, compiler, builder, library and library builder) maintenance and diagnostic programs and test programs (e.g., programmed operational functional appraisal (POFA)). The operational programs shall retain existing program capabilities in conjunction with the added radar tracking and continuous data

recording capabilities. A failsoft capability shall be afforded by the provision of at least three operational levels.

3.2 Equipment and Services to be Furnished

3.2.1 Equipment and Services to be Provided by the Contractor - The contractor shall provide the services and materials necessary to design, fabricate, modify, test, install and integrate the ARTS IIIA system as required by this specification. These shall be provided in quantities and at the times specified by the contract. The work to be performed shall include modifications, installation and checkout of existing Government Furnished Equipment (GFE) as a part of the overall contractor system installation, integration and checkout efforts. The work shall also include equipment unit and subsystem interconnections, testing and demonstration of the ability of the integrated system to meet specified system performance requirements. The work shall be planned so as to assure efficient integration with the existing ARTS III system. On-site work shall be scheduled and conducted so as to impose negligible impact on ongoing operational activities. All installation and checkout work shall be accomplished in this manner and the completed system shall become a part of the existing terminal air traffic control facility. In addition, the contractor shall provide all necessary services and material to prepare, reproduce and provide reports, computer programs and documentation as specified herein. Any feature or item necessary for proper operation in accordance with the requirements of the contract shall be incorporated even though that item or feature may not be specifically described herein.

3.2.1.1 Major Contractor Furnished Services and Equipment - All equipment and services shall be delivered and installed at the locations specified by the Government. All facilities, parts and hardware, including system/subsystem grounding plates, receptacles, connectors, cabling, wiring, adapters, and outlets, except GFE facilities specified in 3.2.2, shall be provided to enable the components of each system to be assembled, interconnected and installed as

required by these specifications. The major items of equipment and services to be furnished are:

(a) Expansion of existing ARTS III data processing subsystems by the addition and modification of equipment including IOPs and memory modules (MM) and if required centralized memory access (CMA) in quantities adequate to support the added system performance requirements specified herein.

(b) Radar Data Acquisition Subsystems

(c) Added Beacon Data Acquisition Subsystems

(d) Peripheral Switch Module

(e) Continuous Data Recording and Medium Speed Printout Equipment

(f) Added and Modified Operational Program and Support Software

(g) Module and System Testing

(h) Special Tools and Test Equipment

(i) Cables, bridging and isolation equipment necessary for interconnecting existing equipment with the new equipment. Installation shall be accomplished between a GFE interface unit (Demarcation Junction Box) and the new equipment. All wiring shall meet FAA-E-1217C sppcification requirements.

(j) Recommended size(s) of circuit breakers, primary power requirements and duct work to be furnished and installed by the Government. The contractor shall be responsible for the design of the grounding system for each field installation.

(k) All required AC power duct, conduit, or other appropriate cable support and power cable between the GFE power panel and the

contractor provided equipment cabinets.

(l) Site installation, test and cutover plans

(m) Documentation

(n) System reliability, availability and maintainability program

(o) Inspection of site preparation work prior to shipment of equipment

(p) Added equipment modules and modification of existing Input/ Output Processors.

(q) Multiplexed Display Buffer Memory

(r) All environmental requirements for various system configurations (e.g., air conditioning, floor loading, space, AC power, etc.)

(s) Reconfiguration and Fault Detection Unit

(t) Break Point Module

3.2.2 Government Furnished Equipment and Services - The Government shall provide or install, or both, where applicable:

(a) Air handling/conditioning that may be required to meet the environmental conditions specified herein

(b) All existing ARTS III equipment

(c) All floor space necessary for the improvements

(d) All ducts (or cable ladders) from the equipment room to the operating display consoles in the TRACON room. AC power distribution panels in the TRACON room, and the equipment room with the number and size of circuit breakers to be specified by the

contractor

(e) All modems required for interfacility data transfer

(f) Cable ladder, duct or other appropriate cable support between the Demarcation Junction Box and the contractor provided equipment cabinets

(g) All grounding wires from existing signal reference plates to all contractor and GFE equipments as necessary to meet the requirements of the grounding system. The grounding system shall be installed in accordance with the design supplied by the contractor and as shown in the approved Installation and Cutover Plan provided by the contractor

(h) All operational and support software associated with the current ARTS III Beacon Tracking Level System

(i) Working space for contractor engineers which includes desks and access to telephones

(j) Drawings of the ARTS III facilities and data necessary for development of the system installation plan

3.3 System Description - New functional capabilities shall be added to and integrated with present ARTS systems as specified in the contract. These added improvements shall result in two general types of systems; (a) Beacon Tracking Level Systems with Continuous Data Recording and added functional capabilities (BTL Systems), Section 3.3.1, and (b) Radar Tracking and Beacon Tracking Level Systems with Continuous Data Recording, Fail-Soft and added functional capabilities (RT & BTL Systems) Section 3.3.2.

3.3.1 BTL Systems - ARTS systems as specified in the contract which will not be upgraded to RT & BTL systems

shall be modified and furnished with on-line continuous, uninterrupted data recording capability (CDR) and the added functional capabilities specified in this document. A disc storage subsystem and a medium speed printer shall be provided for this purpose. The disc subsystem shall be comprised of two 100 megabyte disc pack drives. The contractor shall modify existing ARTS III software as specified by the contract and integrate additional new software required to satisfy the provision of Sections 3.4.1 and 3.6. Wherever necessary additional memory and an I/O channel group shall be furnished. Figure 3-1 illustrates a typical equipment configuration for a BTL system. See note following Section 3.3.2.

3.3.2 RT & BTL Systems - Additional and modified equipment as well as additional and modified software shall be furnished those systems specified in the contract which are to be converted to RT & BTL systems. As a minimum, the additions and modifications shall provide the following functions and capabilities:

(a) Radar Target Detection and Processing
(b) Beacon Radar Correlation and Tracking
(c) Improved Aircraft Tracking Program
(d) Multiprocessor Executive
(e) Expanded Hardware and Software Applications
(f) On-line Continuous, Uninterrupted Data Recording
(g) Failure, Recovery and Reconfiguration (Fail-Soft)
(h) Automatic Overload Sensing and Protection

RT & BTL systems shall have the capability to track and display all non-beacon as well as beacon equipped aircraft. Primary radar detection and processing shall be enabled by the addition of a Radar Data Acquisition Subsystem (RDAS). The modification of existing IOPs and the addition of new IOPs with a multiprocessor executive shall improve the existing tracking program and enable beacon-radar correlation and tracking. These additions shall also enable expanded applications of added peripheral devices, such as disc storage and medium speed printer. Continuous data recording

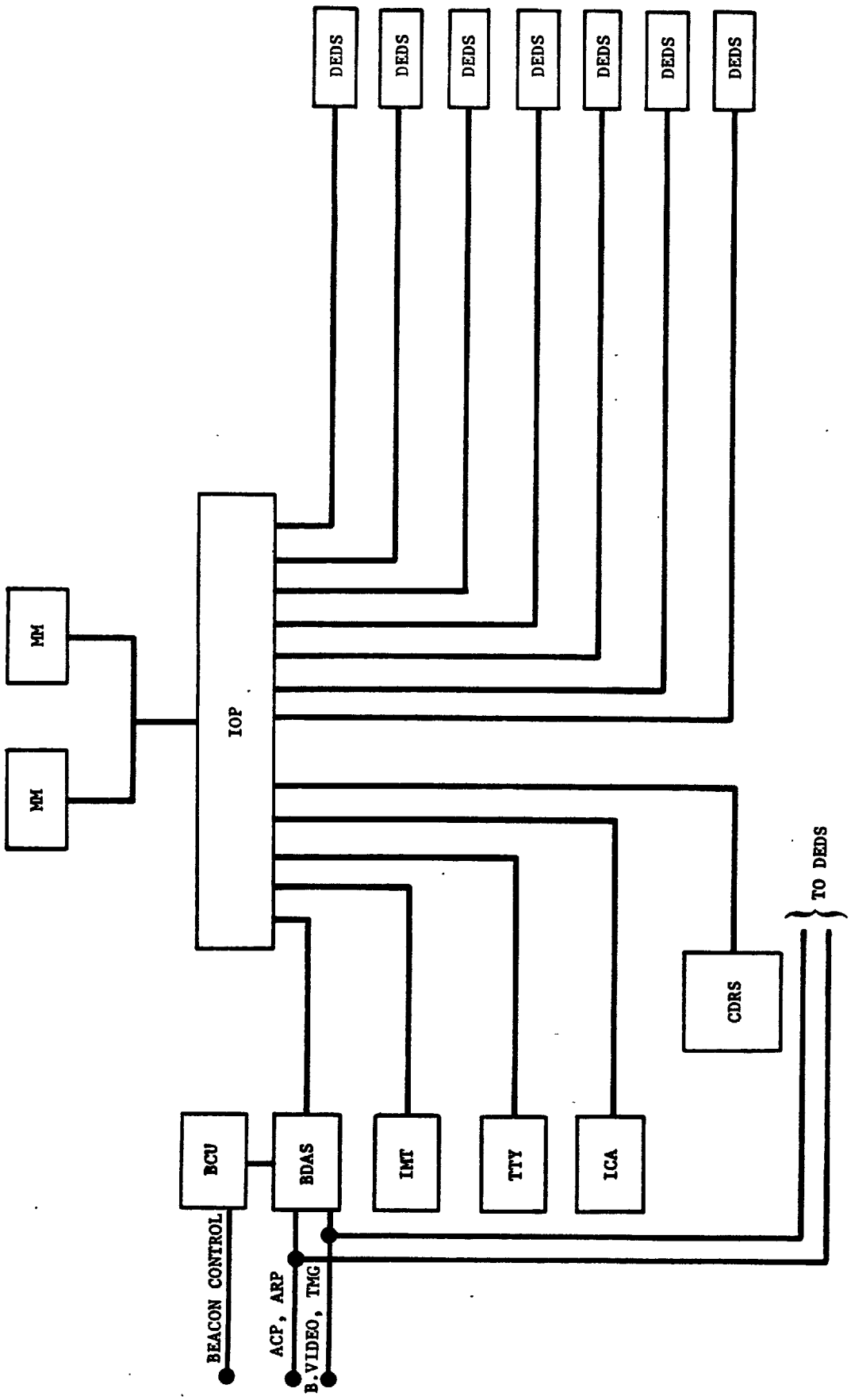

FIGURE 3-1
TYPICAL SINGLE BTL SYSTEM

capability shall be afforded by means of the added peripheral devices as well as utilization of existing peripherals. Fail-Soft capability shall be provided by judicious application of existing and added (including redundant) equipment and software. Availability of secondary (beacon) detection and processing shall be improved by the addition of a Beacon Data Acquisition Subsystem (BDAS) for each sensor. A Beacon Control Unit (BCU) shall be provided for each added BDAS.

Other added equipment and modifications to be furnished by the contractor to support the functional requirements specified in Section 3.4.2 shall include, but not be limited to, modifications to existing IOPs and memory modules (MMs) to the level specified in Sections 3.5.10 and 3.5.11. A Display Buffer Memory Module (DBMM) shall be provided for the purpose of transferring processed data to the Data Entry and Display Subsystem (DEDS) and refreshing and displayed data. A Reconfiguration and Fault Detection Unit (RFDU) and a Peripheral Switch Module (PSM) shall be provided to enable assignment of any MM to any IOP and the BDASs, ICA, TTY adapter, and the IMI to any one of two IOPs.

A three disc drive system shall be provided each system having assembly capability. All other systems shall be provided two disc drive systems. Each disc drive shall be capable of operating with 100 megabyte disc packs. The disc system shall have the capability to support failure reconfiguration and recovery, CDR requirements, subprogram storage, and where required, software assembly requirements. The capabilities of the basic ARTS III system to display broadband video together with computer derived symbology shall be retained.

Figure 3-2 shows a typical single sensor configuration consisting of two IOPs and four MMs. Figure 3-3 shows a typical dual sensor configuration consisting of four IOPs and five MMs.

Note: These figures are provided for information purposes only and do not levy any requirements on the Government or the contractor.

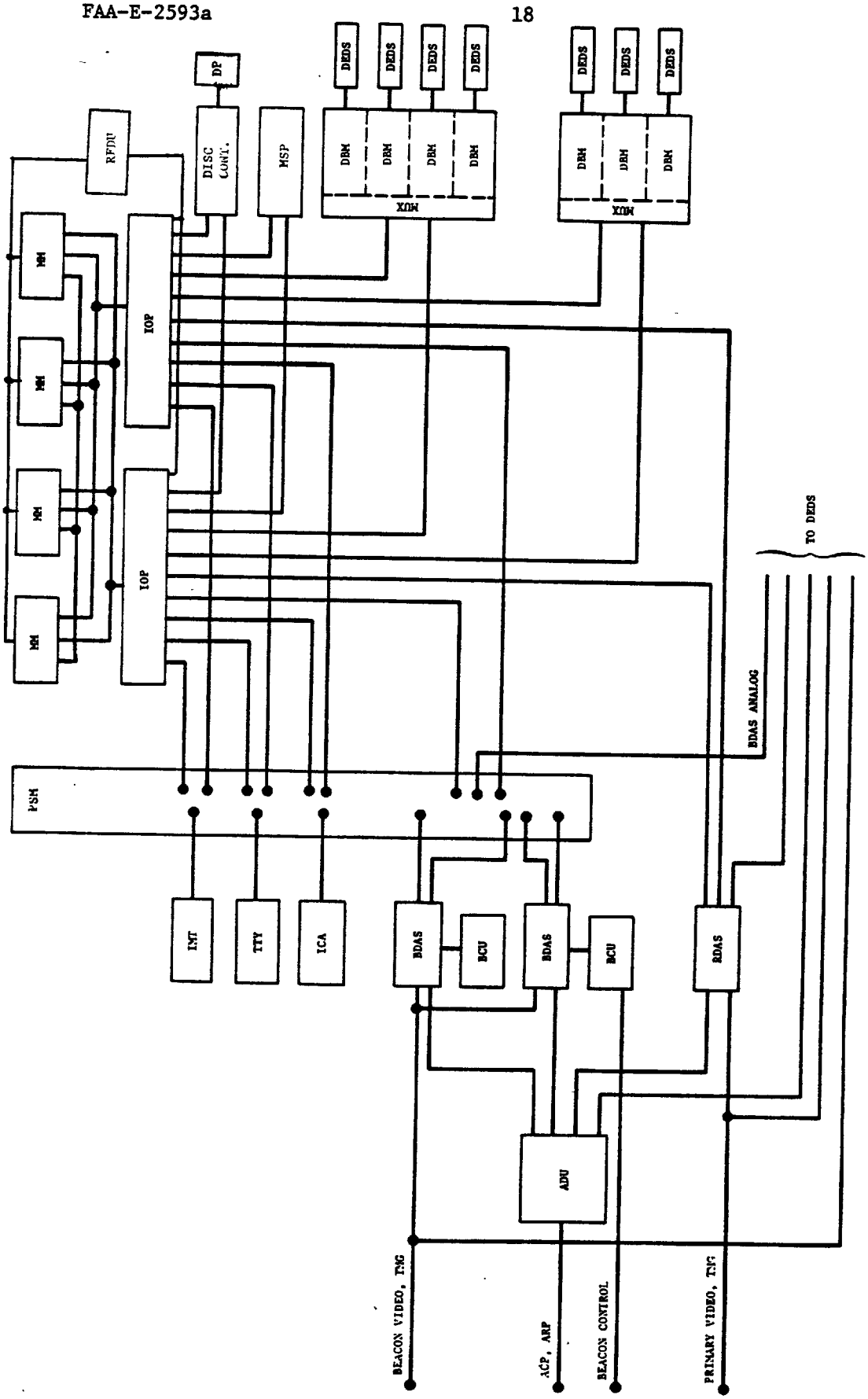

FIGURE 3-2
TYPICAL SINGLE R/BTL SYSTEM

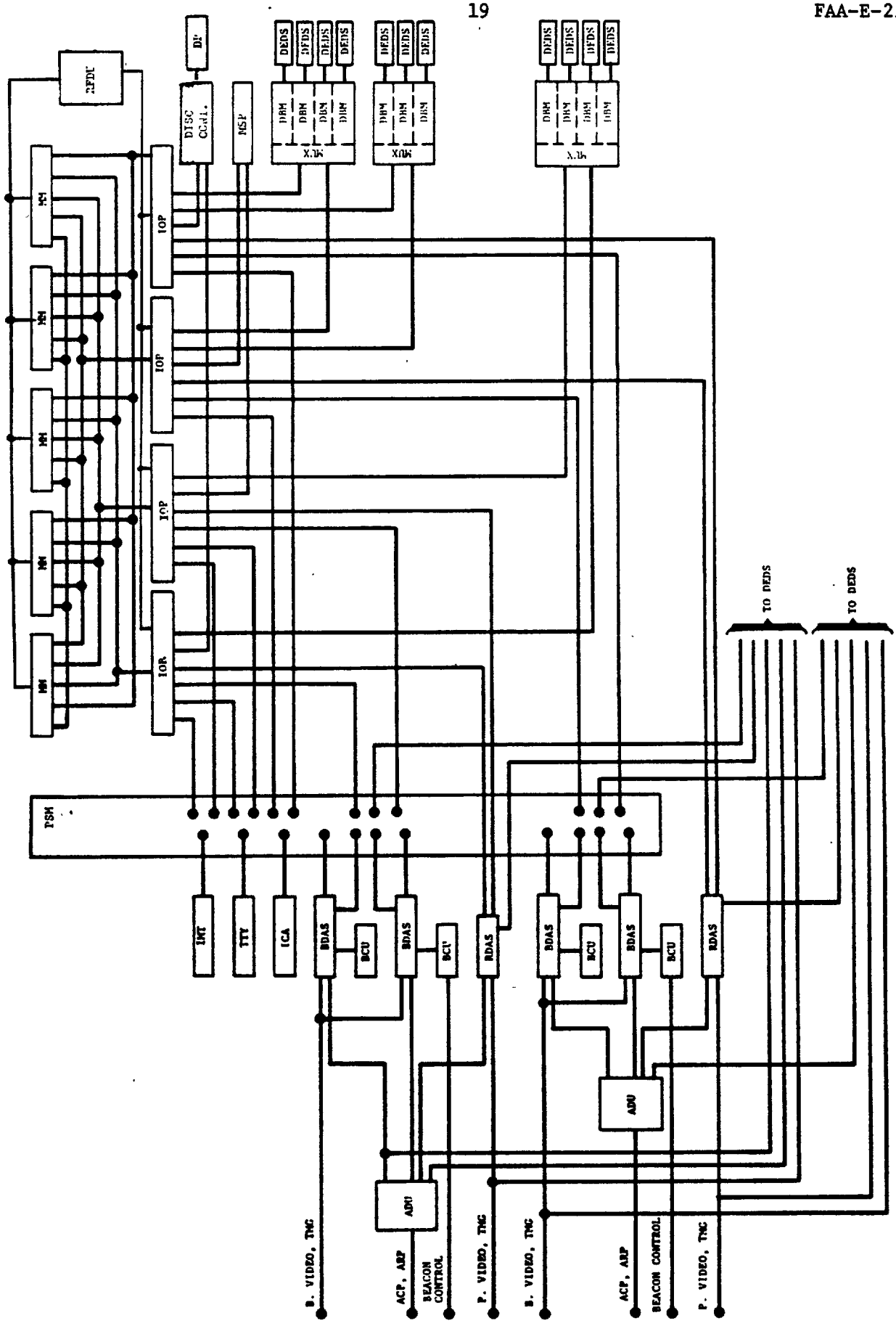

FIGURE 3-3
TYPICAL DUAL R/BTL SYSTEM

3.3.3 BTL and RT & BTL with Additional Functions (Ancillary Tasks) - Ancillary tasks are operational support functions which may be conducted, as specified herein, off-line or on-line concurrent with the full operational program or in a degraded mode not less than first backup level (See 3.6). They shall include, but not be limited to:

(a) Transfer of data from one storage device to another. This shall include the ability to re-record on magnetic tape data already recorded on disc. This task shall provide the capability to transfer data between:

1) Disc and Disc
2) Disc and Memory
3) Magnetic Tape and Memory
4) Magnetic Tape and Disc

(b) Storing, loading and exercise of support, utility, training and limited diagnostic programs and subprograms such as, ETG, BRATS, TIMR, XEF, POFA and training scenarios; i.e., storage on disc so as to permit dynamic call up for on line or off line operation, and program initiation from disc.

(c) Printing of program listings on a MSP or HSP.

(d) Filtering, reduction, editing and printing of recorded data for analysis.

(e) Building and assembly of software programs.

(f) Diagnostics

3.3.3.1 Operational Modes - No more than four operational modes shall be considered in providing system configuration for ancillary task requirements. These shall be:

(a) Mode 0 - No operational capability.

(b) Mode 1 - Operational capability no less than second level backup.

(c) Mode 2 - Operational capability no less than first level backup.

(d) Mode 3 - Full operational capability.

3.3.3.1.1 Ancilliary Tasks BTL and RT & BTL Systems - The contractor shall provide the capability to perform the following ancilliary tasks in an operational mode no lower than that specified below:

Task	Mode		
	BTL Systems	RT & BTL Systems	RT & BTL Systems with Assembly Capability
Magnetic Tape to Memory	3	3	3
Magnetic Tape to Disc	3	3	3
Disc to Memory	3	3	3
Disc to Magnetic Tape	3	3	3
Disc to Disc	3	3	3
Program Listing Printout	0	2	3
CDR Editor Program	0	2	2
CDR Reduction and Printout	0	1	2
Software Assembly	N/A	N/A	2
Limited Diagnostics	0	3	3
Diagnostics	0	2	2

3.4 System Functional Requirements - BTL and RT & BTL systems shall satisfy the functional requirements of current ARTS III Beacon Tracking Level Systems and the additional and/or modified functions specified herein.

3.4.1 BTL System Functional Requirements - Single and dual channel BTL systems shall be provided with the capability of CDR and ancillary functions. The CDR function shall enable the extraction of data during execution of the operational program and the recording of all or selected (filtered - See 3.6) portions of that data on a mass storage subsystem (normally disc). An off-line capability to reduce, edit, filter, analyze and print the recorded data via an editor (See Section 3.6.1.2) on printing equipment (normally a medium speed printer) shall be provided. An on-line capability to transfer data from disc storage to magnetic tape shall also be provided. Ancillary functions, i.e., those enabled by the existence of the disc and MSP subsystems, shall include the capability to store on a disc and utilize from disc, operational and utility programs and subprograms.

3.4.1.1 BTL CDR Requirements - The CDR function shall permit extraction of history and system data during the execution of the operational program and the recording of that data on a mass storage subsystem. Extraction and recording shall be continuous and uninterrupted and shall be capable of being edited, reduced and analyzed by an off-line editor (section 3.6.1.2). An on-line capability to transfer data from the mass storage subsystem (disc) to magnetic tape or from magnetic tape to disc shall also be provided. The extractor shall be modular to allow expansion of the data types that can be extracted and recorded. As a minimum, the capability to extract the data types listed below shall be provided. Selection of these data types shall be site adaptable. The capability of automatic initiation at system startup, as well as dynamic initiation, alteration, and termination, shall be provided on line.

(a) Beacon Reply Data
(b) Beacon Target Data
(c) Tracking Data
(d) Automatic Functions

(e) Manually Entered Functions
(f) Display Data
(g) Interfacility Input and Output Data
(h) Error and Status Message Data
(i) Central Track Store Files including MSAW
(j) Sector Time

It shall be possible to select any combination of the above data types.

Priorities shall be associated with recorded data so that in the event of data overload, low priority data shall be discarded while maintaining high priority data. The function shall monitor its own operation and generate appropriate alarm and error messages. Alarms and error messages shall include, but not be limited to, termination and reinitiation of the extraction of data or data types, application or inhibition of filters, data overflow, changeover from one recording element to another, e.g., disc pack 1 to disc pack 2, disc to magnetic tape unit and system failures.

3.4.1.2 Normal CDR Data Requirements - The CDR function shall provide the capability to record and store all of the data specified in Section 3.4.1.1 when called upon by the program or the operator. However, normal CDR data requirements on a routine daily basis will be:

(a) Tracking Data
(b) Target Reports
(c) Central Track Store Files including MSAW
(d) Automatic Functions
(e) Keyboard Input Data
(f) Interfacility Messages
(g) Sector Time

3.4.1.3 Dynamic Selection and Filtering of CDR Data - An operator, via any keyboard, shall able to control which of the data types will be recorded. The operator shall also be able to terminate or initiate the function as well as to modify other control parameters which filter the data to be recorded. The following filters shall be provided for both on-line recording and off-line editing:

Extractor	Editor
(a) Sensor or Subsystem Number	(a) Sensor or Subsystem Number
(b) Azimuth Limits	(b) Azimuth Limits
(c) Range Limits	(c) Range Limits
(d) Altitude Limits	(d) Altitude Limits
(e) Display Number (Inhibit)	(e) Display Number (Selective)
(f) Beacon Code (Inhibit)	(f) Beacon Code (Selective)
	(g) Aircraft Identification (Selective)
	(h) Parameters Defining Time Period Limits

The extractor filters, above, shall be site adaptable for automatic initiation as well as alterable on line.

3.4.1.4 Mass Storage Subsystem (MSS) - The MSS shall be comprised of a disc storage subsystem, controller modules and a medium speed line printer. Disc drives capable of utilizing 100 megabyte disc packs shall be provided. The disc system shall afford automatic and manual interchangeability to prevent data overflow, preclude data loss due to unit failure and enhance programming and maintenance requirements.

3.4.1.4.1 BTL Ancillary Functions - A capability to utilize existing recording and printing systems (IMT and ASR-37) in conjunction with the disc subsystem equipment shall be provided. These capabilities shall include:

(a) Bootstrap loading and initialization of the

operational program from disc or magnetic tape storage.

(b) On-line automatic and manual control for the transfer of data between disc packs, disc to magnetic tape or magnetic tape to disc.

(c) On-line copying on magnetic tape all or selected portions or segments, e.g., selected time periods, of CDR data already recorded on disc without derogation of the on-going operational functions.

(d) Storage of flight plan data, including interfacility and bulk store, ETG, and utility routines in a manner that they may be acessed and utilized as follows:

(1) Off Line

Utility Routines

Diagnostics

(2) On Line

ETG

BRATS

Flight Plan Data

(e) Automatic and manual selection of any available printer device.

3.4.2 RT & BTL System Functional Requirements - Single and dual sensor RT & BTL systems shall be provided the functional capabilities specified in the succeeding subsections. These capabilities shall include but not be limited to CDR, radar target detection and processing, radar-beacon correlation and tracking, multi-processor executive, and failure detection and automatic reconfiguration and recovery.

3.4.2.1 RT & BTL CDR Requirements - The CDR function

shall permit extraction of history and system data during the execution of the operational program and the recording of that data on a mass storage subsystem. Extraction and recording shall be continuous and uninterrupted and shall be capable of being edited, reduced and analyzed by an editor (Section 3.6.2.2.4). It shall also afford an on-line capability to transfer data from the mass storage subsystem (disc) to magnetic tape or from magnetic tape to disc. The extractor shall be modular to allow expansion of the data types that can be extracted and recorded. As a minimum the capability to extract the data types listed below shall be provided. Selection of these data types shall be site adaptable and be capable of automatic initiation at system startup as well as dynamically alterable on-line:

(a) Radar Reply Data
(b) Radar Target Data
(c) Beacon Reply Data
(d) Beacon Target Data
(e) Correlated Radar and Beacon Data
(f) Tracking Data
(g) Automatic Functions
(h) Manually Entered Functions
(i) Display Data
(j) Interfacility Input and Output Data
(k) Error and Status Message Data
(l) Central Track Store Files including MSAW
(m) Sector Time

It shall be possible to select any combination of the above data types.

Priorities shall be associated with recorded data so that in the event of data overload, low priority data will be discarded while maintaining high priority data. The function shall monitor its own operation and generate appropriate status and error messages. Status and error messages shall include, but not be limited to, termination and reinitiation of the extraction of data or data types, application or inhibition of filters, data overflow, changeover from one recording element to another (e.g., disc pack 1 to disc pack 2 and disc to magnetic tape unit) and CDR element

failures.

3.4.2.1.1 Normal CDR Data Requirements - The CDR function shall provide the capability to record and store all of the data specified in Section 3.4.2.1 when called upon by the program or the operator. However, normal CDR data requirements on a routine daily basis will be:

(a) Radar Tracking Data
(b) Beacon Tracking Data
(c) Radar Target Reports
(d) Beacon Target Reports
(e) Correlated Radar and Beacon Tracking Data
(f) Sector Time
(g) Automatic Functions
(h) Keyboard Input Data
(i) Interfacility Messages

3.4.2.1.2 Dynamic Selection and Filtering of CDR Data - An operator, via any keyboard shall be able to control which of the data types will be recorded. The operator shall also be able to terminate or initiate the function as well as to modify other control parameters which filter the data to be recorded. The following filters shall be provided for both on-line and off-line editing:

Extractor	Editor
(a) Sensor or Subsystem Number	(a) Sensor or Subsystem Number
(b) Azimuth Limits	(b) Azimuth Limits
(c) Range Limits	(c) Range Limits
(d) Altitude Limits	(d) Altitude Limits
(e) Display Number (Inhibit)	(e) Display Number (Selective)
(f) Beacon Code (Inhibit)	(f) Beacon Code (Selective)

(g) Aircraft Identification (Selective)

(h) Parameters Defining Time Period Limits

The extractor filters, above, shall be site adaptable for automatic initiation as well as alterable on line.

3.4.2.2 MSS - The MSS shall be comprised of a disc storage subsystem, and a medium speed line printer. Disc drives capable of utilizing 100 megabyte disc packs shall be provided. The disc system shall afford automatic and manual switching capability between disc drives to prevent data overflow, preclude data loss due to unit failure and to enhance programming and maintenance requirements.

3.4.2.2.1 RT & BIL Ancilliary Functions - A capability to utilize existing recording and printing systems (IMT, UNISERVO VIC, ASR-37, 9300 High Speed Printer) in conjunction with the MSS shall be provided. Ancillary capabilities shall include but not be limited to:

(a) Bootstrap loading and initialization of the operational program from disc or magnetic tape storage.

(b) On-line automatic and manual control for the transfer of data between disc packs, disc to magnetic tape or magnetic tape to disc.

(c) On-line copying on magnetic tape all or selected portions or segments (e.g., selected time periods) of CDR data already recorded on disc without derogation of the on-going operational functions.

(d) Storage of flight plan data, including interfacility and bulk store, training subprograms (e.g., ETG, See Section

3.6.1.1.16) and utility routines. This capability shall be provided so that the software subprograms may be on call, i.e., accessed on line, for immediate functional use in the operational program.

(e) Automatic and manual selection of any available printer device.

(f) Recording of operational critical data necessary to support, failure reconfiguration and recovery requirements.

(g) Storage of minimum of two backup operational programs for failure, reconfiguration and recovery.

(h) In addition to the above RT & BTL systems having assembly capability (i.e., 9300 and UNISERVO VIC equipment) shall be provided the capability to build and assemble complete operational software programs for BTL systems as well as for up to the largest program requirements of RT & BTL systems while maintaining an operational level no lower than first backup level (Section 3.6) and within memory resources not exceeding that required for full system operation.

3.4.2.3 Radar Target Detection and Processing - The Radar Target Detection function shall accept radar video, azimuth, and timing inputs from an Airport Surveillance Radar (ASR) and use this information to generate a radar report for each detected aircraft target on each antenna scan. Radar reports shall contain target range, azimuth, and and target run length in units of azimuth change pulses. They shall be stored in DPS memory in a suitable format for further processing by the Radar and Beacon Tracking Logic. The radar target detection function shall be implemented through the use of a special purpose hardware unit called the Radar Data Acquisition Subsystem (RDAS) in conjunction with a number of stored program routines collectively referred to as the Radar Input Processing (RIP) subprogram. The RDAS shall

perform binary quantization of the radar video and shall send the resulting binary hit data in word format to the DPS. In addition the RDAS shall send to the DPS a pointer to areas containing clutter, and clutter correlation measurements. The RIP software shall accept the inputs from the RDAS and shall make use of these inputs to detect aircraft targets and to control the detection process.

3.4.2.3.1 Target Detection - The detection of radar targets shall be accomplished in four sequential subfunctions: quantization, video selection, predetection, and final detection. Final detection shall be performed in the DPS by the RIP software. The remaining subfunctions shall be performed by the RDAS.

3.4.2.3.2 Quantization - The RDAS shall contain binary amplitude quantizers for simultaneously thresholding two types of radar video. One type of quantizer, the normal quantizer, shall be employed in a clutter free environment and shall establish its threshold by employing a long time constant closed loop noise metering circuit. Another type of quantizer, the clutter quantizer, shall be employed in ground or weather clutter environments. The clutter quantizer(s) shall employ an adaptive threshold technique to perform the binary quantization of the video in clutter areas. The output of the normal and clutter quantizers shall consist of range ordered 1/16 NM binary hits.

The normal quantizer shall accept linear or log normal video inputs. The clutter quantizer(s) shall accept log normal, linear MTI, or log MTI video.

3.4.2.3.3 Video Selection - The simultaneous thresholding of two or more videos can result in more than one binary hit being declared for each range cell. A video selection subfunction shall be performed by the RDAS to determine which video input, after quantization, shall be transferred to the DPS for each range cell. The selection shall be made by the RDAS on the basis of clutter map information received from the DPS (see paragraph 3.6.1.1.1.3). Selected hits shall be formatted in range order within 32 bit computer words for transfer to the DPS.

3.4.2.3.4 Predetection - The RDAS shall perform sequential azimuth integration on the selected hits which are at the same range cell but on adjacent radar sweeps. This sequential azimuth integration shall be used to generate a predetection pointer which shall indicate range cells where potential targets are present. The predetection pointer shall be transferred to the DPS and shall be used by the RIP software in the final detection process.

3.4.2.3.5 Final Detection - The RIP shall perform the final detection process by using the predetection pointer as an index to the selected hits which have been received from the RDAS. A detection window shall be positioned at the range and azimuth of the predetection and a target declaration shall be made when the sum of the hits in the window exceeds a threshold. The threshold shall be controlled dynamically by the RIP Software. Further processing shall be performed on detected targets to generate an estimate of target azimuth and quality.

The azimuth estimation accuracy shall have a standard deviation no greater than 0.2 degrees for a target 6 db stronger than noise.

3.4.2.3.6 Target Detection Control - Control shall be exercised over the target detection process in order to maintain false alarm control while retaining target detection sensitivity. Four subfunctions shall be provided for target detection control: clutter intensity measurement, clutter mapping, clutter correlation measurement, and detection threshold regulation. The clutter intensity and correlation measurement shall be performed in the RDAS, whereas the clutter mapping and detection threshold regulation shall be performed by the RIP software.

3.4.2.3.7 Clutter Intensity Measurement - The RDAS shall contain logic to measure the clutter intensity on each radar sweep. After each radar sweep the RDAS shall transfer to the DPS a computer word which shall indicate areas along the sweep wherein there exist clutter levels.

3.4.2.3.8 Clutter Mapping - The clutter intensity indication received by the DPS from the RDAS shall be processed by the RIP software to generate two stable maps indicating the following conditions: nc clutter, and clutter. These maps, in conjunction with a manually entered ground clutter map shall be used to control the selection of hits for transfer by the RDAS to the DPS.

3.4.2.3.9 Detection Threshold Regulation - The clutter correlation indications received by the DPS from the RDAS shall be processed by RIP Software to generate stable maps indicating various levels of clutter correlation. The clutter correlation maps shall be used to regulate the final detection threshold and if required, the quantization logic to insure proper false alarm control. Final detection threshold regulation shall make use of the existence of tracked aircraft in clutter free areas to enhance detection sensitivity.

3.4.2.3.10 Analog Display Output - The RDAS shall contain an analog output channel as specified in FAA-E-2591.

3.4.2.4 Radar/Beacon Correlation and Tracking

3.4.2.4.1 Target Report Correlation - The Radar/Beacon Correlation program shall search and compare beacon and radar report store data and shall pass each report through to the target report store, as a beacon only report, a radar only report, or as a merged report.

During the processing cycle an attempt shall be made to correlate available beacon reports with available radar reports. Successful correlation shall cause the radar report to be merged with the beacon report and the resulting merged report to be stored in the merged target report store. The merged target position shall be a weighted average of the beacon and radar report positions. Successful correlation is based on the distance between the beacon and radar target positions.

3.4.2.4.2 Tracking - The tracking program shall maintain the correct association between target reports and their corresponding alphanumeric data blocks. This

association shall be maintained for both controlled and uncontrolled beacon and radar targets. Controlled targets are those tracks that have specific flight plan or controller entered identity data associated with them (e.g., ACID, ABC, etc.). Uncontrolled targets are those unused reports that are automatically initiated and tracked but not necessarily associated with a controlled track.

The tracking program shall be developed by modifying the current ARTS III Beacon Tracking Level program to operate under control of the multiprocessor executive, and by the adding of the following functions:

(a) Radar Tracking

(b) Track-oriented smoothing

(c) Deviation scoring (nearest fit) logic to resolve ambiguity between one track and unassociated multiple reports in a bin

(d) Tracking of all aircraft (including auto-initiation)

(e) Deviation trial tracks for turn detection

(f) Tracking feedback to enhance radar detection

(g) Data point offset (upper firmness limit) logic to determine how heavily a correlated report's position should be smoothed

(h) A qualifying score to reflect each track-report relationship

(i) Automatic termination of control tracks which shall include a minimum and maximum velocity criteria

3.4.2.5 Failure Recovery and Reconfiguration - A Failure Recovery and Reconfiguration capability shall be provided for all RT & BTL systems. Hardware and software techniques shall be provided for the detection of equipment module failures or out of tolerance

operation. Failure Recovery and Reconfiguration shall be accomplished automatically as well as by manual procedures or by a combination of automatic and manual procedures. The automatic recovery sequence shall provide that in the event of a second failure indication in the current operating level, another recovery shall be attempted without the use of critical data. Note: This will preclude the possibility of bad data in the data base causing continuous failures.

3.4.2.5.1 DPS Equipment-Module Failure

3.4.2.5.1.1 Failure Detection - Failures shall be detected by software and hardware techniques. Error detection shall include but not be limited to the monitoring of parity, memory resume, memory lockout, power, processor timeout, and illogical conditions.

3.4.2.5.1.2 Recovery and Reconfiguration Sequence - The Recovery and Reconfiguration sequence shall be automatic.

3.4.2.5.1.2.1 Scatter Interrupt - When a failure is detected, a scatter interrupt shall be generated which will stop the operational program from cycling and force each IOP into its NDRO memory and initiate the recovery sequence.

3.4.2.5.1.2.2 Audible Alarm - Five second audible alarm shall be provided for the operations room. The alarm shall have a volume control which shall allow an adjustment range of no preceptible sound to a maximum range of 80 db. The alarm shall be enabled at the start of the recovery sequence. The recovery alarm tone shall be clearly distinguishable from the MSAW alarm tone.

3.4.2.5.1.2.3 NDRO Recovery Program - NDRO memory shall contain a recovery program. This program shall test the IOPs and MMs to determine which are operative and can be used for loading the recovery module. NDRO shall contain at least two selectable NDRO bootstrap routines (i.e., disc and magnetic tape). The recovery module shall be called in by the lowest numbered operative IOP whose mass storage device bootstrap has

been enabled. If that load is unsuccessful, the second lowest numbered operative IOP with mass storage device bootstrap enabled shall attempt the load and then the third lowest, etc. If all attempts to load the recovery module from the mass storage device are unsuccessful, then the load shall be attempted by the lowest numbered IOP that has an IMT bootstrap enabled and then second lowest, etc.

3.4.2.5.1.2.4 Recovery Module - The Recovery Module consists of software routines that conduct detailed checks on all DPS equipment modules. It shall determine which equipment module(s) are operable and then call in the highest level selected backup operational program that can operate in those modules. Startup of the backup operational program shall be automatic. A capability to manually select between two backup operational programs that utilize identical data processing resources shall be provided. The recovery module shall respond to the selection and load the proper backup operational program.

3.4.2.5.1.2.5 Failure Data - All failure data shall be output on a printer. Failure data shall include but not be limited to:

(a) An IOP and MM resources map.

(b) The identity of the selected operational program.

(c) All data presently required on the ARTS III Fault Log (NAS Documentation Form 7500-65) shall be printed out except data not accessable by the operational program.

(d) NDRO program failure indicators.

(e) Recovery module failure data.

(f) Time of failure.

3.4.2.5.1.3 Program Storage - The capability to store operational and support software programs on the integral magnetic tape unit (IMT) or other mass storage

device (disc or UNISERVO VIC) shall be provided. The capability to load software programs or segments thereof into the DPS from any available storage device shall also be provided. The latter capability must be provided so that subprogram loads may be accomplished and executed while the operational program is cycling. The IMT shall be the alternate program storage unit and shall be used when the mass storage device has failed.

3.4.2.5.1.4 Critical Data - The operational program shall record critical data on the mass storage device for use after a recovery and reconfiguration sequence. Critical data shall include, but not be limited to the most recent track data, flight plan data in core storage, system configuration, systems data including time, selected beacon codes, general systems information, and software initiation parameters.

3.4.2.5.1.5 MM and IOP Partitioning and Isolation - An automatic and manual reconfiguration and partitioning function shall be provided as part of the RFDU to permit positive partitioning of all combinations of MMs/IOPs. In the event of an IOP or MM failure, the RFDU shall provide the necessary switching so that the failed element can be isolated from the operating system. The partitioning function shall also allow groups of off-line equipment modules to be connected together into working subsystems for maintenance or other purposes. There shall be no interaction between off-line equipment modules and the on-line system except for shared use of peripheral devices.

When off-line equipment modules are switched on-line, there shall be no effect on the operating system until a manual input action is taken or a DPS equipment module failure occurs. The manual input action or the DPS failure shall cause the system to enter the recovery and reconfiguration sequence. The manual input command shall be capable of being entered from either the TTY keyboard or a DEDS keyboard. When the TTY keyboard is being used for entry purposes, output messages shall be retained for later printing.

3.4.2.5.1.6 Startup - The recovery and reconfiguration sequence shall be automatically entered for all

operational program startups. Startup shall be initiated by the Single Button Start on the RFDU.

3.4.2.5.2 Disc Storage Device Failure

3.4.2.5.2.1 Failure Detection - Monitoring of disc storage device operation shall include but not be limited to parity checks, timeout checks, reading of test patterns from write protect devices and the writing and reading of test patterns on other disc storage devices.

Two attempts to complete an operation shall be made. If the failure condition persists after the second attempt then a printout of the failure data shall be made.

Two attempts to complete the operation shall then be made through the alternate I/O channels. The operation shall be attempted sequentially on each channel until either a successfull attempt has occurred or a failure has been encountered on all channels. Appropriate error message printouts indicating success or containing failure data shall be made.

If the attempts to complete the operation through the I/O channels have all failed, then the system shall test all disc drives to determine whether the malfunction resides in a disc drive or in the controller and appropriate failure data shall be output.

3.4.2.5.2.2 Automatic Reconfiguration - When a disc drive failure has been detected, the operation shall be completed (when possible) by using another disc drive.

If a disc overload is sensed, an automatic switchover to another disc shall occur.

Except for disc drive or I/O channel failures, no automatic reconfiguration shall be provided except that if the recovery sequence is entered, operation shall be as specified in Section 3.4.2.5.1.2.3.

3.4.2.5.2.3 Manual Reconfiguration - A capability to

manually energize each individual I/O channel or all I/O channels together shall be provided on the disc controller. Input messages shall be provided to select which channel shall be utilized by the system.

3.4.2.5.3 TTY Failure.

3.4.2.5.3.1 Failure Detection - Failure detection shall include but not be limited to parity and timeout monitoring. If a timeout problem is detected, an attempt to complete the operation through all alternate TTY I/O channels shall be made before a failure is declared.

3.4.2.5.3.2 Automatic Reconfiguration - The TTY printer shall be used as the principal output device for recording all error, failure and status information. When a TTY failure is detected, these messages shall be output on the MSP, so that no data is lost.

3.4.2.5.3.3 Manual Reconfiguration - A capability to connect the TTY to any one of two IOPs shall be included on the PSM.

A capability to manually enter input messages from either the TTY keyboard or a DEDS keyboard to designate either the TTY or the MSP for the output of selected error, failure and status messages shall be provided.

3.4.2.5.4 BDAS Failure

3.4.2.5.4.1 Failure Detection - BDAS failures shall be detected by a combination of hardware fault monitors in the BDAS which report failure indications to the DPS and by the operational software. Failure detection shall include but not be limited to range, azimuth interlace, test target, parity and timeout monitoring.

Failures shall be declared whenever the error rate exceeds a predetermined threshold (SP).

Whenever a failure is declared, a printout of the failure data shall be made.

3.4.2.5.4.2 Automatic Reconfiguration - Whenever a failure is detected, the DPS shall utilize data from the alternate BDAS. A printout of this action shall be made. After automatically switching to the alternate BDAS, a check of normal BDAS failure parameters will be made. If a failure exists, a delay of N seconds (SP) will occur before switching back to the original BDAS. If after N seconds the failure still exists, the reconfiguration shall operate as originally provided. Again, a printout of this action shall be provided.

3.4.2.5.4.3 Manual Reconfiguration - A capability to connect each BDAS to either one of two IOPs shall be included on the PSM. The switching shall be arranged such that the output of two BDASs cannot be connected together.

A capability to connect the DEDS to either of two BDAS analog signals shall be included on the PSM. A positive indication as to which IOP is receiving BDAS data shall be provided so that the correct BDAS analog signals can be connected to the DEDS.

Manual input messages shall be provided to direct IOP/BDAS operation. Messages shall include a capability to reinitiate the automatic reconfiguration mode and designate the IOP(s) that will receive BDAS data. These manual input messages shall be capable of being entered from either the TTY keyboard or a DEDS keyboard.

3.4.2.5.5 RDAS Failure

3.4.2.5.5.1 Failure Detection - RDAS failures shall be detected by a combination of hardware fault monitors in the RDAS which report failure indications to the DPS and by the operational software. Failure detection shall include but not be limited to range, azimuth, RTQC test target, parity and timeout monitoring. Failures shall be declared whenever the failure rate exceeds a predetermined threshold (SP).

A printout of the failure data shall occur whenever a failure is declared.

3.4.2.5.5.2 Manual Reconfiguration - A capability to manually select I/O channels shall be provided on the RDAS as specified in FAA-E-2591a.

The operational software shall be capable of responding to these selections. An input message shall be provided to manually select which channel shall be utilized by the system if both channels are energized.

3.4.2.5.6 MDBM and DEDS Failures

3.4.2.5.6.1 Failure Detection - Monitoring of MDBM and DEDS operation shall include but not be limited to parity test messages, and timeout checks.

If a failure is detected, two attempts to complete the operation shall be made before a failure is declared and a failure data printout occurs.

When a failure is declared, two attempts shall then be made to complete the operation on the alternate channel and a printout indicating success or containing failure data shall be made.

No further special treatment of the error condition shall be made except as directed by manual input messages.

3.4.2.5.6.2 Manual Reconfiguration - A capability to manually select I/O channels shall be provided on the MDBM.

A manual input message capability shall be provided that shall stop or restart display output processing or keyboard input processing for any selected DEDS. It shall be possible to enter these messages from any DEDS keyboard. Whenever a restart message is entered, the failure declaration sequence of Section 3.4.2.5.6.1 shall be enabled.

3.4.2.5.7 Medium Speed Printer (MSP) Failure

3.4.2.5.7.1 Failure Detection - Failure detection shall include but not be limited to parity and timeout monitoring.

When an operation results in an error two attempts to complete that operation shall be made. If the failure condition persists after the second attempt, then a printout of the failure data shall be made.

Two attempts to complete that operation shall then be made through the second I/O channel and a printout indicating success or containing failure data shall be made.

3.4.2.5.7.2 Automatic Reconfiguration - Except for I/O channel related failures, no automatic reconfiguration shall be provided.

3.4.2.5.7.3 Manual Reconfiguration - A capability to manually select I/O channels shall be provided on the MSP. Three selections shall be provided; (1) on-line, which activates both channels, (2) channel zero only active, and (3) channel one only active. An input message capability shall be provided to select which channel shall be used by the system if both channels are energized. A printout of this action shall be provided.

3.4.2.5.8 Integral Magnetic Tape (IMT) Failure

3.4.2.5.8.1 Failure Detection - Failure detection shall include but not be limited to parity, timeout monitoring and the writing and reading of test messages. If a failure is detected, such that it appears that the IMT is disconnected from the I/O channel in use, attempts to complete the operation through the alternate I/O channel shall be made before a failure is declared and a failure printout is generated.

3.4.2.5.8.2 Automatic Reconfiguration - No automatic reconfiguration shall be provided.

3.4.2.5.8.3 Manual Reconfiguration - A capability to connect the IMT to either one of two IOPs shall be included on the PSM. The system shall be capable of determining (automatically) which I/O channel is connected to the IMT.

3.4.2.5.9 Interfacility Communications Adapter (ICA)

3.4.2.5.9.1 Failure Detection - Failure detection shall include but not be limited to parity, timeout monitoring and test message cycling. If a failure is detected such that it appears that the ICA is disconnected from the I/O channel in use, two (2) attempts to complete the operation through the alternate I/O channel shall be made before a failure is declared and a failure printout generated.

3.4.2.5.9.2 Automatic Reconfiguration - No automatic reconfiguration shall be provided.

3.4.2.5.9.3 Manual Reconfiguration - A capability to connect the ICA to either one of two IOPs shall be provided on the PSM. The system shall be capable of determining (automatically) which I/O channel is connected to the ICA.

3.4.2.6 Multiprocessing - The IOP shall contain features specifically designed to provide an efficient multiprocessing capability. These features shall include but not be limited to:

(a) Memory lockout

(b) Relative memory addressing

(c) Table access control

(d) Biased load and store

The multiprocessing executive shall meet the requirements of Section 3.6.2.1.1.1.1 and shall be designed to make maximum use of the IOP multiprocessing features to ensure that an efficient use of data processing resources is obtained when executing the operational program(s).

3.4.2.7 Automatic Overload Sensing and Protection - To assure sustained processing power for air traffic control priorities, the contractor shall furnish software capability to automatically sense and protect against primary radar data overload situations (e.g.,

radar malfunction/failure, jamming and intense weather echoes). When an overload situation occurs, radar data processing shall be discriminately and dynamically reduced in a manner assuring optimum operational capability. That is, radar processing shall be inhibited in those azimuthal portions of the scan where the input data rate is excessive. Those portions of the radar scan where the data rate is normal or low shall not be affected.

3.4.2.7.1 Keyboard Inputs - A DEDS keyboard input action shall be provided that will enable or disable this function. A teletype printout shall follow the action indicating the status of the function.

3.4.2.7.2 Display Output - An indication of the azimuth segments wherein radar data processing is inhibited shall be presented on the DEDS.

3.4.2.7.3 CDR - A CDR output shall be provided each scan that radar data processing is inhibited. The output shall indicate which segments are affected. This output shall be considered as one of the Automatic Function data types.

3.5 Equipment Requirements - The existing ARTS III hardware systems shall be modularly expanded and modified to meet the functional capabilities as specified herein. As a minimum the following equipment shall be furnished; in accordance with FAA-E-2591a:

(a) Radar Data Acquisition Subsystem (RDAS)

(b) Beacon Data Acquisition Subsystem (BDAS)

(c) Beacon Control Unit (BCU)

(d) Azimuth Distribution Unit (ADU)

(e) Disc Subsystem

(f) Reconfiguration and Fault Dtection Unit (RFDU)

(g) Multiplexed Display Buffer Memory (MDBM)

(h) Input/Output Processor (IOP)

(i) Memory Modules (MM)

(j) Medium Speed Printer

(k) Break Point Module (BPM)

(l) Peripheral Switch Module (PSM)

3.5.1 Radar Data Acquisition Subsystem (RDAS) - An RDAS shall be provided for each single RT & BTL system. Two RDAS's shall be provided for each dual RT & BTL system. The RDAS shall meet the requirements of FAA-E-2591a and shall be adapted to match the characteristics of the primary radar system to which it is connected.

3.5.2 Beacon Data Acquisition Subsystem (BDAS) - One additional BDAS shall be provided for each single RT & BTL system. Two additional BDAS's shall be provided for each dual RT & BTL system. The BDAS shall meet the requirements of FAA-E-2591a and shall be adapted to match the characteristics of the beacon system to which it is connected.

Additional cabinets (FA-8302), DC/DC Power Converters (FA-8307A) and AC/DC Regulators (FA-8308A) that meet the requirements of FAA-E-2591a shall be provided to house and power the BDASs.

3.5.3 Beacon Control Unit (BCU) - A BCU shall be provided with each additional BDAS. It shall be connected to its corresponding BDAS to provide audible and visual alarms for emergency and radio failure situations, but shall not be connected to the beacon system. The BCU shall meet the requirements of FAA-E-2591a.

3.5.4 Azimuth Distribution Unit (ADU) - An ADU shall be provided for each single RT & BTL system. Two ADU's shall be provided for each dual RT & BTL system. When required by the contract schedule, an optional synchro data converter shall be included in the ADU. The ADU shall meet the requirements of FAA-E-2591a.

3.5.5 Disc Subsystem - One dual channel disc subsystem shall be provided for each BTL and RT & BTL system. The disc subsystem for non-assembly facilities shall consist of one disc controller and two disc drives. The disc subsystem for assembly facilities shall consist of one disc controller and three disc drives.

3.5.6 Reconfiguration and Fault Detection Unit (RFDU) - The RFDU shall provide automatic confguration control of IOPs and MMs for both the single and dual RT & BTL systems, per the requirements of FAA-E-2591a. In addition, there will be a manual switching capability to fully isolate an MM or IOP from the remaining system.

3.5.7 Multiplexed Display Buffer Memory (MDBM) - The MDBM shall consist of redundant multiplexers/Demultiplexers and a number of Display Buffer Memory Modules (DBMMs). The number of MDBM's and DBMM's shall be determined by the number of displays at each facility. The MDBM shall meet the requirements of FAA-E-2591a.

3.5.8 Input/Output Processor (IOP) - Existing IOPs at RT & BTL facilities shall be modified tc convert them to FA-8303B type IOPs. Additional IOPs shall be provided as necessary to meet the processing requirements as specified herein and in the contract. The IOPs shall meet the requirements of FAA-E-2591a.

Sufficient cabinets (FA-8301), DC/DC Power Converters (FA-8307B) and AC/DC Regulators (FA-8308B) that meet the requirements of FAA-E-2591a shall be provided to house and power the IOPs.

3.5.9 Memory Modules (MM) - Existing MMs at RT & BTL facilities shall be modified to meet the MM requirements of FAA-E-2591a. Additional MMs shall be provided as necessary to meet the processing requirements as specified herein and in the contract. These MMs shall also meet the requirements of FAA-E-2591a.

Sufficient cabinets (FA-8301), DC/DC Power Converters (FA-8307C), and AC/DC Regulators (FA-8308B) that meet

the requirements of FAA-E-2591a shall be provided to house and power the MMs.

3.5.10 Central Memory Access Module (CMA) - CMAs shall be provided for those data processing subsystems where the number of IOPs and/or MMs are such that a CMA is required. The CMAs shall meet the requirements of FAA-E-2591a. Where CMAs are provided, the memory modules are to be modified for single port operation.

3.5.11 Medium Speed Printer (MSP) - An MSP shall be provided for each BTL and RT & BTL system. The MSP shall meet the requirements of FAA-E-2591a.

3.5.12 Break Point Module (BPM) - A BPM shall be provided and have the following functions. It shall be an 18 bit, 6 function switch selectable device that shall be capable of stopping the IOP in selected Store, Fetch or Instruction sequences and in address conditions of Less Than, Equal or Greater Than a preselected 18 bit address. The BPM shall be capable of operation in any non-exclusive combination of the six conditions.

3.5.13 Peripheral Switch Module (PSM) - The PSM shall provide manual configuration control of IOPs and peripheral equipment per the requirements of FAA-E-2591a.

3.6 Software Requirements - Separate software shall be provided for BTL systems (section 3.6.1) and for RT&BTL systems (section 3.6.2).

3.6.1 BTL Software - Cperational software (section 3.6.1.1) and support software (section 3.6.1.2) shall be provided for the BTL systems.

3.6.1.1 Operational BTL Software - BTL operational software shall ccnsist of mutually agreed upon FAA released ARTS III software modified by the addition of the Continuous Data Recording (CDR) software described below. The BTL software shall be such that the BTL system with CDR is functionally identical to the existing BTL systems as specified in the contract except that added CDR functions shall be provided. The

CDR shall extract in real time selected data processed during the execution of the operational program. The CDR function shall process that extracted data for storage on a recording media in such a manner as to allow editing of the data and its printout on a medium speed printer. The CDR function shall not adversely impact program timing.

3.6.1.1.1 Extractor - The extractor shall have the capability to write on disc storage or on magnetic tape, as a minimum, the following input/output data:

(a) Beacon Reply Data

(b) Beacon Target Data

(c) Tracking Data

(d) Automatic Functions

(e) Manually Entered Functions (keyboard)

(f) Display Data (note)

(g) Interfacility (input and output) Data

(h) Error and Status Message Data

(i) Central Track Store Files including MSAW

(Note: The data that is displayed in the tabular lists and the system data area.)

Nothing in the design shall preclude the later inclusion of other types of data, e.g., metering and spacing and minimum safe altitude warning data.

The extractor shall place the desired data in a buffer area. When one buffer is filled, a record from that buffer shall be written on the designated recording media (disc or magnetic tape) while further extraction is continued and the data stored in another buffer. When the other buffer is filled another record shall be written. The buffer areas shall be used alternately/sequentially in this manner while the

program is in operation.

In the event that a buffer area becomes full before another is available, i.e., recording is not completed, a "Data Loss" condition shall exist. This condition shall result in the following action:

(a) The program shall stop extracting data selectively on the basis of software adapted priorities. The data having the lower priority shall be deleted first. If deletion of more than one type data becomes necessary, the next lowest priority data shall be deleted. Priorities shall be as follows (where the lowest priority has the highest number):

1. Track Data
2. Target Data
3. Interfacility Input and Output Data
4. Keyboard Entries
5. Reply Data
6. All other data

(b) A printout noting the time of data loss and the type of data no longer being extracted shall occur on the appropriate printer.

(c) Extraction of the suspended data shall be automatically reintiated in priority order when the overload situation is cleared. A printout shall occur noting the time and type data being restored.

(d) Overload conditions shall not affect the operational program.

3.6.1.1.1.1 Automatic Initiation of Extraction - When system startup is completed, CDR shall be automatically initiated by commencing extraction using a standard set

of data (site adaptable) with standard (site adaptable) limitations (filters). Selective extraction of a specific data may be inhibited or enabled or filter limitations entered by keyboard entries. When the extractor is initiated automatically or manually, it shall write the data via the buffer areas on the designated recording media. When the area designated for writing data within a disc pack is filled an automatic transfer to the standby disc pack shall occur. When magnetic tape is used, in the event of disc failure it shall be manually initiated and continue writing until it receives an end of tape interrupt or is manually switched. The extractor shall initiate the disc unit designated "available" (automatically or by manual switch action) and continue output on that element. When the end of tape or manual interrupt is received on the magnetic tape unit a tape mark shall be written on the tape and the transport shall rewind to BOT. Whenever a transfer from one recording element (disc to disc, disc to tape or tape to disc) to another occurs, a message indicating the time and status of the extractor shall be output on the TTY printer, or MSP if so designated. If at any time, including initiation, interrupts are received from the designated disc indicating a failure or not ready, the extractor shall switch to the alternate disc. In all of the foregoing cases a message indicating time and extractor status shall be printed on the TTY printer, or MSP, if so designated.

3.6.1.1.1.2 Extractor Control - The extractor shall be controlled by input messages from any display console alphanumeric keyboard or TTY having supervisory status. The operator shall be provided the capability to initiate extraction, select, add to, or inhibit extraction types, alter filter controls and terminate extraction while the main program is operating. The following filters shall exist and may be used in any combination:

(a) Sensor or Subsystem Number

(b) Azimuth Limits

(c) Range Limits

(d) Beacon Code

(e) Altitude Limits

(f) Display Number

The purpose of extractor filters is to reduce the amount of data to be recorded by screening out non-desirable information, e.g., display data output to a maintenance or other unused display normally need not be recorded. The filters shall be applied as follows:

(a) Sensor or Subsystem Number. A keyboard entry to inhibit or enable recording of data from either or both radar/beacon sensors shall be provided.

(b) Azimuth Limits. A capability to enter up to 3 azimuths shall be provided. This filter shall be sensor oriented.

(c) Range Limits. A capability to enter up to 3 ranges shall be provided. This filter shall be sensor oriented.

Note: The azimuth and range filters working in conjunction shall enable the non-recording of data whose origin is beyond the boundaries described.

(d) Beacon Code. A capability to enter up to 5 beacon codes shall be provided. This function shall inhibit the recording of the data associated with these codes. This filter shall be sensor oriented.

(e) Altitude Limits. The capability to enter an upper altitude limit shall be provided. This function shall inhibit the recording of data whose origin is above the specified altitude. This filter shall be sensor oriented.

(f) Display Number. A capability to enter up to 5 display numbers shall be provided. This function shall inhibit the recording of any

data output to the specified displays.

Filters designated sensor oriented shall be applicable separately and independently to each sensor. They shall also be automatically initiated, per local adaptation, upon startup and dynamically alterable on line.

3.6.1.1.1.2.1 Keyboard Messages - Keyboard messages shall consist of fields. The first two should be, for example, "F7" and X. These should be followed by qualifying (data type) fields specifying the functions to be performed and the limitation of that performance. A record of all keyboard entries shall be printed on the TTY printer, or the MSP, if so designated.

3.6.1.1.1.2.2 Manual CDR Program Initiation, Date and Time - Upon automatic initiation at startup, the CDR program shall make reference to and record the computer system time until it is updated to chronological time by the operator. At this point, the CDR program shall record that time sequence in hours, minutes and milliseconds. A keyboard message shall be used to enter the date. When the F7, X message is followed by fields containing EE, two digits of the day, two digits of the month and two digits of the year, the CDR program shall be initiated, or continue to operate if already enabled and immediately commence updating the entered date value on a daily and monthly basis until the program is manually or otherwise terminated. When the initiation/date message is further followed with fields containing RM, X (where X equals 0, 1, 2) it shall designate the recording media; 0 = magnetic tape, 1 = disc drive 1, and 2 = disc drive 2. If a recording unit is not specified disc drive 1 shall be assumed.

3.6.1.1.1.2.3 Data Type and Control - The following keyboard messages shall permit dynamic suppression or reinitiation of the extraction of the data or specified data type(s). The entry of a reinitiation message for a data type whether inhibited or not inhibited, shall alter its priority for automatic suspension to the highest level. That is, the first data type to be reinitiated shall maintain highest priority until a second data type is reinitiated. Then it would be

degraded to second level, then third, then fourth, as succeeding data types are reinitiated. The entries for enabling or inhibiting the extraction of data types shall be F7, X followed by:

ENTRY		FUNCTION	DATA TYPE
Enable	Inhibit		
ER	IR*	Enable/Inhibit Extraction of	Radar Data**
EB	IB*	Enable/Inhibit Extraction of	Beacon Replies
ET	IT*	Enable/Inhibit Extraction of	Target Reports
EF	IF	Enable/Inhibit Extraction of	Tracking Data
EK	IK	Enable/Inhibit Extraction of	Keyboard Data
EI	II	Enable/Inhibit Extraction of	Interfacility Input Messages
EO	IO	Enable/Inhibit Extraction of	Interfacility Output Messages
EA	IA	Enable/Inhibit Extraction of	Automatic Functions
EM	IM	Enable/Inhibit Extraction of	Magnetic Tape Flight Plans
ES	IS	Enable/ Inhibit Extraction of	System Data (Memory Dump)
ED	ID	Enable/Inhibit Extraction of	Display Data
EE(da, mo, yr)	IE	Enable/Inhibit	Extractor (All Data)

* Sensor Ø or 1 - If neither is entered all available shall be assumed.

** RT & BTL Systems only.

Note: The above messages shall be enterable in the multiple mode.

3.6.1.1.1.2.4 Extractor Limit Control - The extractor shall also provide dynamic capability tc select the altitude, range and azimuth within which sensor inputs, (beacon replies, target reports, and tracking data) may be extracted. The following keyboard messages shall be available to enable the operator to establish, alter or terminate altitude range and/or azimuth filters per sensor.

(a) Range Filter - This message shall cause the extractor to extract only data within the range(s) for the sensor specified. If no sensor is specified all available sensors shall be assumed. The format should be: xx, yy, zz (sensor 0 or 1) where xx, yy and zz are ranges expressed by the two digits and specified in nautical miles.

(b) Azimuth Filter - This message shall cause the extractor to extract only data within and including the angle(s) specified by x, y, and/or z for the sensor(s) specified. If no sensor is specified, all available sensors shall be assumed. A capability to select up to three azimuths shall be provided. Azimuth(s) shall be entered in three decimal digits representing degrees. The format should be: F7, X, AF, xxx, yyy, zzz, (sensor 0 or 1).

(c) Altitude Filter - This message shall cause the extractor to ignore uncontrolled Mode C tracks indicating an altitude above that specified. The altitude limit shall be represented as three decimal digits. The format should be F7, X, FA, xxx, where xxx equals altitude expressed in three digits, e.g. 091 = 9100 ft.

MESSAGE OUTPUT				DESCRIPTION
DR START	(K)		(Time)	Initialize Extractor
DR STOP-M	(K)		(Time)	Manual Extractor Termination
DR STOP	(M)		(Time)	Program Extractor Termination
DR ADEL MAG			(Time)	Auto Delete Mag Tape Flight Plans
DR ADEL IF			(Time)	Auto Delete Interfacility Messages
DR ADEL AUT			(Time)	Auto Delete Auto Functions
DR ADEL KBD			(Time)	Auto Delete Keyboard Data
DR ADEL TRK	(Sensor)		(Time)	Auto Delete Tracking Data
DR ADEL TGR	(Sensor)		(Time)	Auto Delete Target Reports
DR ADEL BNR	(Sensor)		(Time)	Auto Delete Beacon Replies
DR ADEL RVD	(Sensor)		(Time)	Auto Delete Radar Data
DR ARES MAG			(Time)	Auto Resume Mag Tape Flight Plans
DR ARES IF			(Time)	Auto Resume Interfacility
DR ARES AUT			(Time)	Auto Resume Auto Functions
DR ARES KBD			(Time)	Auto Resume Keyboard Data
DR ARES TRK	(Sensor)		(Time)	Auto Resume Tracking Data
DR ARES TGR	(Sensor)		(Time)	Auto Resume Target Reports
DR ARES BNR	(Sensor)		(Time)	Auto Resume Beacon Replies
DR ARES RVD	(Sensor)		(Time)	Auto Resume Radar Data Input
DR MDEL MAG	(K)		(Time)	Manual Delete Mag Tape Flight Plans
DR MDEL IF	(K)		(Time)	Manual Delete Interfacility
DR MDEL AUT	(K)		(Time)	Manual Delete Auto Functions
DR MDEL KBD	(K)		(Time)	Manual Delete Keyboard Data
DR MDEL TRK	(K)	(Sensor)	(Time)	Manual Delete Tracking Data
DR MDEL TGR	(K)	(Sensor)	(Time)	Manual Delete Target Report
DR MDEL BNR	(K)	(Sensor)	(Time)	Manual Delete Beacon Replies
DR MDEL RVD	(K)	(Sensor)	(Time)	Manual Delete Radar Data Input
DR MRES MAG	(K)		(Time)	Manual Resume Mag Tape Flight Plans
DR MRES IF	(K)		(Time)	Manual Resume Interfacility
DR MRES AUT	(K)		(Time)	Manual Resume Auto Functions
DR MRES KBD	(K)		(Time)	Manual Resume Keyboard Data
DR MRES TRK	(K)	(Sensor)	(Time)	Manual Resume Tracking Data
DR MRES TGR	(K)	(Sensor)	(Time)	Manual Resume Target Reports
DR MRES BNR	(K)	(Sensor)	(Time)	Manual Resume Beacon Replies
DR MRES RVD	(K)	(Sensor)	(Time)	Manual Resume Radar Data

3.6.1.1.2 Enhanced Target Generator - A capability shall exist to simulate the activities of a number of aircraft. The target generator shall accept commands from display keyboards or from a scenario magnetic tape (prepared off-line) to simulate the flight paths of up to 64 independent aircraft. The target generator shall accept parameter inputs from the display keyboard, and the scenario magnetic tape to control the mode of operation as well as the characteristics of targets. Commands shall control the following target characteristics.

(a) Beacon code and validity

(b) Altitude and validity

(c) Rate of ascent/descent

(d) Range

(e) Heading

(f) Rate of Change of Heading

(g) Speed

(h) Acceleration/Deceleration

(i) Special Position Indicator (SPI)

(j) Weak/Strong Target

(k) Radar and/or Beacon Targets

(l) Radar Target Run Length

The target generator shall have the following general functional capabilities:

(a) Add noise in target position.

(b) Duplicate targets.

(c) Ring targets.

(d) Control of Blip/Scan ratio and beacon fade.

(e) Identification of targets on display.

(f) Scenario control of targets from magnetic tape (prepared off-line).

(g) Selected displays isolated for target generator operation only.

3.6.1.1.3 Ancilliary Software - The contractor shall furnish software capable of performing system support functions. For example, to satisfy the requirement to rerecord on magnetic tape system data already stored on disc to provide the ability to promptly investigate an air traffic incident either on site or at another computer location. As a minimum a capability to perform the tasks listed and in the mode specified in Section 3.3.3 shall be provided.

3.6.1.2 Support BTL Software - Additional support software shall be provided for BTL systems. This support software shall be integrated with existing support software. The additional support software deals only with the CDR system. Two types of support software shall be provided: A CDR editor (section 3.6.1.2.1) and CDR diagnostics (section 3.6.1.2.2).

3.6.1.2.1 Editor - The editor program shall provide printer output of data written by the CDR extractor (see section 3.6.1.1.1). The editor shall be capable of operating in an IOP with one 16K memory module. It shall be capable of operation with the following equipment complex:

(a) Mass Storage (Disc)
(b) Medium Speed Printer
(c) Input/Output Processor (IOP)
(d) 16K Memory Module
(e) Integrated Magnetic Tape Unit (IMT)
(f) Console Teletypewriter

The editor shall be furnished on a magnetic tape in the same format as the operational program. It shall have the capability of being loaded into the DPS using

standard IOP procedures from either the IMT or from a mass media storage unit. The operator shall have control of the data filter limits as specified in 3.6.1.2.1.1 and the following data types:

(a) Radar Data (RT & BTL only)

1. Replies

2. Reports

(b) Beacon Data

1. Replies

2. Reports

(c) Tracking Data

(d) Auto Functions

(e) Keyboard Input

(f) Interfacility

1. Input

2. Output

(g) Central Track Store Files including MSAW

(h) Bulk Store Flight Plans

(i) Display Data

(j) Error and Status Message Data

It shall be possible to select all, any one, or any combination of the above.

Following a program start the console teletypewriter shall print: ENTER DATA TYPE(s).

A carriage return shall be entered if all types of data are to be listed. Otherwise, letters specifying which

data are to be listed shall be entered. The last letter designator desired shall be followed by a carriage return. The letter designators shall be:

DATA TYPE	LETTER DESIGNATOR
Radar Replies*	O
Radar Reports*	V
Beacon Replies	H
Beacon Reports	R
Tracking Data	T
Auto Functions	A
Keyboard Input** (followed by keyboards xx)	K (x,x)
Interfacility Input	I
Interfacility Output	F
Function Summary	S
Display Data**	D

3.6.1.2.1.1 Filters - A filter is a parameter or range of values for which the data editing shall be in effect. This shall enable the operator to examine specific data without having to printout all extracted data. The following filters shall be provided:

(a) Time (Start and End)
(b) Sensor or Subsystem Number
(c) Azimuth (Start and End)
(d) Range (Minimum and Maximum)

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*RT & BTL only
**If no keyboard/display is entered, all shall be assumed.

(e) Beacon Code (Discrete or Nondiscrete Blocks)
(f) Aircraft ID
(g) Altitude Limits
(h) Display Number
(i) Interfacility Messages (data type PP, AM, CX, TA, TI, TU, DA, DX, DR, TR, DT, DM)
(j) Tracking Data (controlled and uncontrolled)

All filters shall be capable of operating simultaneously or in any combination and they shall be selectable by keyboard entry. The aircraft ID filter shall handle up to five aircraft at once. The beacon code shall be able to handle up to five beacon codes at once.

3.6.1.2.1.2 CDR Editor Output - CDR editor output shall include, but not be limited to, the following:

(a) If more than one data category has been entered, the first data category entered shall be printed first.

(b) Each category of data shall have its own format and column heading which shall be printed on all sheets containing that data category.

(c) A capability for beacon data reduction which shall enable:

- o Printing all duplicate beacon reports for any scan in which a duplicate report is found.
- o Printing all duplicate beacon reports of any selected code block for any scan in which a duplicate is found.
- o Printing all dupicate beacon reports of any selected discrete code for any scan in which a duplicate is found.

(d) For each type of data reduction the following statistics for each scan shall be provided:

- o Total number of Mode 3/A targets
- o Total number of targets
- o Total number of Mode C targets

(e) The CDR editor shall also:

- o Print azimuth in ACPs or degrees.
- o Print time in seconds or hundredths of seconds as well as hours and minutes.
- o Stop the printing at the next scan via jump key setting.
- o Print scan time only for those scans in which something is found for which print has been requested.
- o Recycle to program initialization without a need for reload.

3.6.1.2.2 Diagnostic Programs - The contractor shall supply a set of CDR equipment-oriented diagnostic programs which operate "off-line" on a manual call basis. These diagnostic programs shall include the features necessary to meet the equipment maintainability requirements specified in this specification.

3.6.2 RT & BTL Software - Complete operational software (section 3.6.2.1) and support software (section 3.6.2.2) shall be provided for RT & BTL systems.

3.6.2.1 Operational RT & BTL Software - Operational software for both single sensor systems (section 3.6.2.1.1) and dual sensor systems (section 3.6.2.1.2) shall be provided for RT & BTL systems. Software, in object form, for single and dual sensors shall be identical except for (SP).

These operational programs (software) shall be similar to existing ARTS III programs in that all logically

independent functions shall be segmented into separate subprograms (tasks). It shall be possible to change, delete, or add to one or more subprograms without affecting the remaining (unchanged) portions of the operational program. All parts of an operational program must be relocatable within main memory.

Each task shall be capable of assembly independent of the executive and other tasks. A capability shall exist to modify, insert, or delete tasks without changing the executive or the unaffected tasks.

3.6.2.1.1 Single RT & BTL Operational Software - The operational software to be provided for single RT & BTL sites will include:

(a) Full Capability Single RT & BTL Operational Program (Section 3.6.2.1.1.1)

(b) First Backup Single RT & BTL Operational Program (Section 3.6.2.1.1.2)

(c) Second Backup Single RT & BTL Operational Program (Section 3.6.2.1.1.3)

Whenever system degrading and reconfiguration is necessary an interfacility "stop send" message shall be transmitted. When reconfiguration is completed an Interfacility "start send" message shall be transmitted.

First backup software shall be a subset of full capability software. Whenever a failure occurs or at the time of initialization (see section 3.4.3.3), the system will always choose the highest level program consistent with available hardware, where full capability ranks highest, first backup next, and second backup ranks third. An indication of the operating program level shall be displayed on the DEDS at all times.

During normal operation, that is with all IOPs and MMs operating properly, the full capability software controls the system. At this time, this software is resident in main memory, and backup software and a copy

of full capability software is on a mass storage device. If, in the event of failures, or for any other reasons, there is insufficient properly operating hardware for full capability software operation, first backup software will automatically be placed in main memory and assume control of the system. When sufficient properly operating hardware again becomes available, full capability software will replace first backup software for control of the system. This replacement will be initiated by an input command.

The source RT & BTL program for all three RT & BTL Operational Programs shall be the same. Through the use of the assembler and the Builder, this source RT & BTL program shall be capable of being assembled into any one of the three types of RT & BTL Operational Programs (the object RT & BTL Operational Programs) mentioned above and placed on a mass storage device suitable for bootstrap loading. Recursive and re-entrant coding techniques shall be available for use in both the Multiprocessor Executive and the tasks.

3.6.2.1.1.1 Full Capability Single RT & BTL Operational Program - The full capability single RT & BTL operational program shall be composed of a Multiprocessing Executive (see section 3.6.2.1.1.1.1), functional tasks, and a System Data Base (see section 3.6.2.1.1.1.1.7). These functional tasks are:

(a) Beacon Input Processing (see section 3.6.2.1.1.1.2)

(b) Radar Input Processing (see section 3.6.2.1.1.1.3)

(c) Radar/Beacon Correlation (see section 3.6.2.1.1.1.4)

(d) Radar/Beacon Tracking (see section 3.6.2.1.1.1.5)

(e) Keyboard Input Processing (see section 3.6.2.1.1.1.6)

(f) Display Output Processing (see section

3.6.2.1.1.1.7)

(g) Automatic Offset (see section 3.6.2.1.1.1.8)

(h) Interfacility Processing (see section 3.6.2.1.1.1.9)

(i) Bulk Store Flight Plan Processing (see section 3.6.2.1.1.1.10)

(j) Continuous Data Recording (see section 3.6.2.1.1.1.11)

(k) Time Out Processing (see section 3.6.2.1.1.1.12)

(l) Thread Update (see section 3.6.2.1.1.1.13)

(m) Output Message Processing (see section 3.6.2.1.1.1.14)

(n) Critical Data Recording (see section 3.6.2.1.1.1.15)

(o) Enhanced Target Generator (see section 3.6.2.1.1.1.16)

(p) MSAW (see section 3.6.2.1.1.1.18)

3.6.2.1.1.1.1 Multiprocessor Executive - The Multiprocessor Executive is responsible for the operation of the IOPs and their peripheral devices. During system operation, it will control the execution of the Operational Program as well as detect system failures and implement recovery logic.

The executive shall be capable of being executed by any IOP. It shall have dynamic storage allocation capability for relative addressing to any 16,384 word MM. The executive shall be designed to operate in, and control system configurations of up to eight IOPs and 16 MMs.

Care shall be exercised so that the task workload shall be distributed among the computing processors and also

so that highly interfacing tasks (memory fetch interference or simultaneous access to a given data item) shall not frequently be executed at the same time. This shall be achieved in the executive controlled system through the preplan of the parallelism among tasks. That is, the majority of tasks shall be prescheduled within a network of other tasks. This network, called a lattice, shall describe all tasks which are prerequisites for any given task and all tasks which are successors to the given tasks. Tasks scheduled via a lattice are called "planned" tasks. Tasks which have aperiodic scheduling characteristics are called "popup" tasks. A list of popup tasks entrance times shall be maintained and popup task entrance control performed accordingly by the Executive.

The executive shall provide the basic functions of system initialization, task scheduling, servicing request, controlling interrupts, and system recovery (not otherwise handled by NDRO or off-line software). These functions are described below. To facilitate system growth or changes, executive functions may be added, changed, or deleted, even though some executive functions may share the same tasks and portions of the data base.

The Executive shall provide for:

(a) System Initialization - The capability to initialize the system hardware and software for either an inital system start or a recovery restart (startover). Parts of the system initialization function may be contained in the executive. Initialization shall be controlled by a single IOP.

(b) Task Scheduling - Task scheduling for the dispatch of program control to tasks within the Operational Program. Two types of query shall exist within the scheduler: the popup query and the planned query. The popup query shall provide high priority entrance to tasks which are aperiodic or for which excessive overhead would exist if they were planned.

The planned capability shall provide a number of lattice frameworks in which tasks may be placed so that entrance is dependent upon the prior completion of other tasks or the lapse of a given amount of time. Tasks may be scheduled as both a popup and a planned task. This feature will permit a task to be scheduled periodically and yet still provide a fast response for critical functions.

(c) Executive Service Requests (ESRs) - A set of ESRs shall be made available to tasks for the general capabilities of I/O control, scheduling control, privileged instruction execution, and normal task exit. The Teletype handler shall provide an I/O message control capability for operator/task and operator/executive interface. Logical to physical I/O device assignments and their backups shall be site adaptable.

(d) Interrupt Control - An interrupt capability to control all levels of both intraprocessor and interprocessor interrupt conditions. There shall be two types of interprocessor interrupts. One type is for input/ output and originates in the ESR routine, and the other type shall inform the non-initializing processors that the initialization is complete and to proceed with normal task scheduling.

(e) Recovery - In the event of detection of a system error, the Recovery and Reconfiguration Sequence (see section 3.4.2.5) shall be initiated. Portions of the function of recovery and reconfiguration may be contained in the executive.

3.6.2.1.1.1.2 Beacon Input Processing - The Beacon Input Processing (BIP) tasks shall accept and process replies from the Beacon Data Acquisition Subsystem (BDAS), correlate them on a sweep-to-sweep basis to detect targets, and store the declared target messages for use by the beacon/radar correlation subprogram.

The beacon input processing tasks shall also monitor BDAS/BIP performance. Functionally, the beacon input processing tasks shall perform as per NAS-MD-606 with the exception that BIP shall be operated on a schedule basis.

The input received from the BDAS for each sweep shall consist of an interrupt word, an initial word, and up to 30 reply words. The initial word shall be checked for reasonable azimuth, proper interrogation mode (mode interlace), and alarm bit setting. Alarm printouts shall be generated in case of failure or error condition.

The reply words shall be used for correlation with previously received reply words for possible generation of target report messages. System parameters shall be used for determining firm targets, split targets, and ring-around conditions. Declaration of a firm target shall result in the storage of applicable data in the beacon target report store for subsequent processing by the beacon/radar correlation subprogram. This data shall consist of range, center azimuth, mode 3/A code, mode C code (if present), validity field for each code, SPI bit, and, a weak/strong target indicator based on azimuth confidence. Mcde C validity shall be checked at all times. A count of the interrupts received shall be maintained to determine Pulse Repetition Frequency (PRF), rate and an alarm printout shall be initiated if the count is not within limits.

Receipt of an internal test target shall also be verified once each scan. A test target shall be located approximately 32 ACPs in a clockwise direction from 180 degrees at a range of 59 1/16 nautical miles. Failure to locate the BDAS test generated target shall result in a error printout.

3.6.2.1.1.1.3 Radar Input Processing - The Radar Input Processing (RIP) program shall ccntrol the RDAS/RIP interface. It shall process the RDAS data for the statistical detection and position reporting of radar replies. It shall additionally provide the control for the RDAS video channel selection, weather hit regulation, and other computer selectable operating

parameters. The radar input processing program shall be capable of performing the following functions:

(a) Control the input of RDAS data into assigned storage areas. These data include quantized target video hits, clutter monitor data, target predetection indicators, isolated hit data, radar antenna azimuth, and RDAS status codes.

(b) Search the predetection data and perform statistical detection tests to declare target reports.

(c) Determine the range run length and center azimuth of detected targets.

(d) Eliminate radar reports in clutter areas when the total hit count from the target falls below an acceptable level.

(e) Assign report quality, merge reports from adjacent range cells, and pass completed reports to the beacon/radar correlation program.

(f) Correlate weather hit data on a sweep-to-sweep and scan-to-scan basis.

(g) Correlate clutter monitor data on a sweep-to-sweep and scan-to-scan basis. Generate quantizer select maps used to select RDAS quantizers. Provide for quantizer selection on a 2-mile by 32-ACP zone basis.

(h) Output the zone control map which regulates the quantizer selection in the RDAS.

(i) Transfer command words to the RDAS for selection of operating parameters.

(j) Monitor the RDAS and radar input processing program performance.

(k) Generate error alarms for abnormal

conditions.

(l) Control the generation and positioning of the Realtime Quality Control (RTQC) test target.

(m) Control RDAS alarm indications

(n) Provide overload sensing and protection

3.6.2.1.1.1.4 Radar/Beacon Correlation - The Radar/Beacon Correlatien Functions shall combine radar and beacon reports received from the same aircraft into one merged radar reinforced beacon report. The position estimate for the radar reinforced report shall be derived from a weighted average of the beacon and radar report position estimates. Radar/beacon correlation shall first be attempted prior to track correlation. Beacon reports which fail correlation on ths first attempt shall be subject tc another attempt at radar correlation within the track correlation logic.

A radar target report may be declared before its beacon correlative (if it exists) or vice versa for some sensors (e.g., DABS). For that reason some radar reports shall be held in the radar report store and some beacon reports shall be held in the beacon report store throughout additional processing cycles to assure that all report pairs that qualify are correlated. These additional cycles shall not exceed the expected time required to complete the correlative reports (a system parameter). If correlation has not been achieved in this time interval, the reports shall be inserted into the appropriate report store as a radar only target or as a beacon only target.

3.6.2.1.1.1.5 Radar/Beacon Tracking - The Beacon Tracking Level (BTL) ARTS III tracker shall be modified to include the features described in the following sections. Among the added features shall be the capability of automatically initiating and terminating tracks on all aircraft within the ASR surveillance areas. In addition, modification to the correlation logic shall provide for the combination of radar and beacon reports from the same aircraft, improved cross

referencing, deviation scoring, and improved turning track correlation. To improve tracking on turns the smoothing algorithm shall be modified to provide the capability for applying different smoothing criteria along and across the direction of track motion. The selection of smoothing parameters shall be made more adaptive. For primary targets a tracking feedback loop shall be established to improve the target detection sensitivity in the areas of predicted track position.

3.6.2.1.1.1.5.1 Automatic Track Initiation - An algorithm shall be provided to initiate tracks automatically on all radar and/or beacon target reports. The automatic initiation logic shall apply a different scan-to-scan correlation criteria for radar reports, beacon reports with radar reinforcement, and beacon reports without radar reinforcement. The automatic initiation logic shall provide for the filtering of radar clutter and beacon fruit through the use of speed, direction, and run length criteria. Tracks will not be initiated on primary only target reports which occur in areas defined as heavy clutter by the clutter mapping function.

3.6.2.1.1.1.5.2 Termination of Controlled Track Status - When a controlled track status is automatically or manually changed to uncontrolled (e.g., via the geography dependent feature of the tracker, or the track suspend or track drop keyboard entry) the appropriate uncontrolled track symbol shall be immediately associated with and displayed for that track. In addition, a velocity criteria shall be provided which shall automatically terminate a controlled track (change from controlled to uncontrolled status) when its velocity is not within parametric (site parameter) values.

3.6.2.1.1.1.5.3 Smoothing Improvement - The BTL ARTS III smoothing (correction) algorithm shall be modified to include the use of track- oriented smoothing (TOS). TOS involves the rotation of the X-Y coordinate system to correspond with the direction of track motion prior to computing smoothed track position. The use of TOS adds the capability of using different alpha-beta smoothing parameters along the across track direction.

An additional capability to be added is the ability to dynamically set the upper limits for the alpha-beta smoothing parameters.

3.6.2.1.1.1.5.4 Tracking Feedback - The tracking logic shall generate a range-azimuth gate around the predicted position of firmly established tracks which have been correlating with poor quality radar reports. If the gate is within a clutter free area it shall be used by the radar target detection logic to lower the detection criteria within the gate.

3.6.2.1.1.1.5.5 Improved Cross-referencing - The ARTS III cross-referencing scheme shall be expanded to include the use of qualifying scores to resolve ambiguous situations. The qualifying scores shall indicate numerically the relationship between each report and the track(s) with which it is eligible to be correlated. The qualifying score shall take into account report validity or quality, beacon code agreement between report and track, gabled and emergency code conditions, and the type of track which is being processed for correlation.

3.6.2.1.1.1.5.6 Deviation Trial - The turning track logic shall be modified to include the formation of a deviation trial track in the specific case wherein no reports are found in a normal track's primary bin, but exactly one is found in its secondary bin with proper qualifying score. The deviation trial track's predicted position shall be formed by straight line predicting from a smoothed position and the normal tracks predicted position. The deviation trial shall become a normal track after two successive correlations. The use of the deviation trial track shall eliminate the necessity of generating two turning trial tracks in the specific case described above.

3.6.2.1.1.1.5.7 Correlation Bin Size for Coasting Tracks - In the case wherein two reports of any type both exist in two different tracks' correlation bins such that an ambiguous situation results which is not resolveable either through qualifying scoring or correlation with other tracks, the two tracks shall be coasted but the correlation bins shall not be increased

in size.

3.6.2.1.1.1.5.8 Deviation Scoring - In the case wherein more than one report is in a track's primary bin each with equal qualifying scores and none of these reports is associated with another track, deviation scoring shall be attempted to resolve the ambiguity. The deviation score is arrived at by computing the distance between each report position and the track predicted position, taking into account the relative errors in range and azimuth. The report with lowest score (smallest error-weighted distance) is correlated to the track.

3.6.2.1.1.1.5.9 Minimum Safe Altitude Warning (MSAW) - The Radar/Beacon tracking program shall also provide for the requirements of the MSAW program as implemented in ARTS III version A0.12.

3.6.2.1.1.1.6 Keyboard Input Processing - Keyboard data shall be input to the ARTS IIIA operational program from each Data Entry Display System (DEDS). The input data from each DEDS shall consist of one Type 1 word (display console settings: range scale and off-centering) and three Type II words (keyboard data: quick look selection, trackball coordinate changes, and data/function characters).

The Keyboard Input Processing program shall process all DEDS channel interrupts, preview all input messages, and process all operational function requests. Operational function requests relate to track control, flight data, display control, system parameters, system configuration, implied functions and enhanced target generation.

Keyboard input processing shall be as per NAS-MD-608 with the following added messages:

(a) To control the Continuous and the Enhanced Target Generator.

(b) Messages shall be added to enable system configuration, initiate recovery sequence, load backup and standby programs and enable

or disable the overload sensing and protection function.

(c) To control the RDAS analog output.

(d) The current ARTS III keyboard functions of START TRACK and DROP TRACK shall be changed in concept because all targets shall be tracked. However, the software functions to initiate and associate flight data with a displayed target or drop it shall remain the same. The contractor shall make the necessary documentation changes and procure the necessary key covers to denote these functions as Initiate Control (IC) and Terminate Control (TC).

3.6.2.1.1.1.7 Display Output Processing - The Display Output Processing function involves the preparation and transfer of data to the display buffer memory and the maintenance of the buffer memory P-stack (up to 64 words per display). The P-stack controls the transfer of data from the buffer memory to the display (refresh). The display output tasks shall be divided into separate subroutines in order to effectively handle the variety of data to be presented and to meet the individual update frequencies required for the various data.

The data to be transferred to each display may be divided into eight separate categories:

1. Active controlled aircraft (two or three line FDB or single symbol)

2. Inactive controlled aircraft (tabular lists)

3. Uncontrolled aircraft (LDB or single symbol)

4. System data (alphanumeric)

5. Keyboard Preview and Readout data (alphanumeric)

6. Trackball position (symbol)

7. Radar data processing inhibition indicators

8. Minimum Safe Altitude Warning (MSAW)

Display output processing shall be as described in NAS-MD-609 and the following: a. The virgule (/) shall be displayed to indicate uncontrolled primary radar only targets. b. Limited Data Blocks (LDB) for primary radar only targets shall display ground speed when requested by the operator via slewball and enter button. c. Displayed data are output via Display Buffer Memory Module which controls the refreshing of the displays.

3.6.2.1.1.1.8 Automatic Offset - The Automatic Offset function (selectable at each display by keyboard entry) shall attempt to minimize alphanumeric format overlapping at each display per NAS-MD-609, Section 8.

The active controlled track formats at each display shall be periodically checked to determine if format overlap exists. If overlap is detected, the offset of one of the formats shall be changed. Only the active tracks controlled at one display shall be considered. No attempt shall be made to prohibit an active track format from overlapping with uncontrolled track readouts, quick look tracks, handoff tracks, tabular lists, preview data, or single symbols (representing other controlled or uncontrolled aircraft). Also, no attempt shall be made to prohibit crossing leaders. When the overlap condition no longer exists, the data block shall be returned to its initial position.

3.6.2.1.1.1.9 Interfacility I/O Processing - The Interfacility program shall input and process all data received from the ARTCC, and pack and output all messages to the ARTCC. These data and messages include flight data, track data and responses. The Interfacility program shall be as per NAS-MD-610 and shall satisfy the requirements of NAS-MD-601.

3.6.2.1.1.1.10 Bulk Store Flight Plan Processing - The input of flight plan (FP) information from bulk store shall provide automatic initiation of aircraft records and controller/aircraft assignment for prestored

(scheduled) aircraft. The FP input capability shall be an independent operational function with on-line operator control. The magnetic tape input may be used in conjunction with or without interfacility (ARTCC) communication.

A capability to load the FP data, prestored on magnetic tape in time-ordered sequence, into disc storage shall be provided. The data shall then be taken from its storage element (tape or disc) validated, formatted, and processed per NAS-MD-611.

3.6.2.1.1.1.11 Continuous Data Recording - The Continuous Data Recording program shall extract radar, beacon and other data during execution of the operational program and transfer all or part of that data to an external storage device. The data shall be extracted and recorded continuously. The stored data shall be capable of being edited, reduced, and anlayzed by an off-line editor (see section 3.6.2.2.4).

In addition, a capability shall exist to extract radar target data and/or beacon target data either at the input or output of the radar/beacon correlation function. Thus, extraction of all radar-detected targets, radar-only targets, unreinforced beacon targets and reinforced beacon targets shall be possible.

Continuous data recording shall function as described in sections 3.6.1.1 through 3.6.1.2.1.2 except that radar replies and radar targets shall also be extracted. Filter characteristics described in section 3.6.1.1.1.2 shall apply to primary (search) data where applicable and primary (search) only shall be added as a filter item.

3.6.2.1.1.1.12 Timeout Processing - System Timeout Processing consists of unrelated time tasks which must be periodically executed under executive control. These tasks include but are not necessarily limited to:

(a) Timeout I/O activity on all of the DEDS channels

(b) Timeout the receipt of beacon target inputs from the BDAS

(c) Update the clock time displayed on each display console

(d) Monitor controlled track files set up for a one-second delayed terminate

(e) Perform the three (system paramter) scan countdown on all accepted handoffs.

(f) Monitor flight plans

(g) Timeout the data transfers to and from the RDAS

(h) Perform the three (system parameter) scan countdown on all identified (multifunction, BCN) uncontrolled track readouts

(i) Monitor the EM/RF/HJ/SA presentation in the system data area

(j) CTS capacity test

(k) Automatic track drop/handoff

(l) Timeout radar input processing

(m) Check RDAS alignment

(n) Re-enable reply processing following suspension due to malfunction.

3.6.2.1.1.1.13 Thread Update Task - The operational program shall perform its track file (controlled, uncontrolled and unused) processing through the use of various threads in Central Track Store (CTS) and Track Number Pointer table. The simultaneous execution of tasks that use these threads shall not result in the altering of a thread by one task while another task is using that thread.

Each thread modification shall be performed as a unique

task. This routine shall check to see if any thread changes have been requested. When a thread change request is detected, this routine shall then determine which of the threads to update and then update that thread.

3.6.2.1.1.1.14 Output Message Processing - This task supports other tasks by transferring messages generated throughout the system to an output device. These messages are of three types:

(a) Recording (hardcopy) of significant system changes.

(b) Internal error or alarm messages.

(c) Configuration status request messages.

This task shall be as per NAS-MD-612 with the addition of:

(a) Internal error or alarm messages for new subsysems (e.g., RDAS, CDR) and functions (see para. 3.6.1.1.4).

(b) System configuration messages that include equipment configuration as well as display position configuration.

(c) Output shall normally be to TTY. The MSP shall be used as a backup to TTY.

3.6.2.1.1.1.15 Critical Data - As part of the system recovery sequence a capability shall exist to restore the system to the air traffic and control situation which existed at the time the system entered the recovery mode.

When the system is restored by a restart using critical data, all FDBs shall be forced into the coast list, not timed out. FDBs in handoff status shall be handled in the following manner:

(a) Clear all bits indicating that the FDB is in handoff status.

(b) If the ARTCC transmits a Track Update (TU) message for any flight plan with interfacility eligibility, reset the bits indicating that an Initiate Transfer (IT) message has been received and use the X, Y coordinates from the TU to position the FDB.

(c) When the ARTCC has accepted the handoff and the FDB is in countdown to be dropped when the fault occurred, auto-acquire from the coast list and reinitialize the countdown.

Critical operational data shall be extracted continuously during system operation and stored on a mass storage subsystem to effect such restoration. The data which is so extracted shall be selectable by a manual action, and shall include, but not be limited to the following types of data:

(a) Aircraft identification (ACID)

(b) Track positicn coordinates

(c) Altitude

(d) Ground Speed

(e) Control status (controller ID)

(f) Radar/beacon correlation status

(g) Track store tables

(h) DEDS configuration

3.6.2.1.1.1.16 Enhanced Target Generator - The Enhanced Target Generator shall be as specified in paragraph 3.6.1.1.2.

3.6.2.1.1.1.17 System Data Base - The data base for the RT & BTL system shall be predicated on the ARTS III Beacon Tracking Level program but shall be enhanced to satisfy the functions specified herein. Part of the data base shall be site adaptation data to define such site variable items such as number of displays. It

shall consist of, but not be limited to, the following:

(a) Radar/Beacon Target Store

(b) Beacon Report Store

(c) Radar Report Store

(d) Central Track Store

(e) Track Present Map

(f) Radar Detection Map

(g) Console Typewriter Print Request Tables

(h) Display/Keyboard Parameter Tables

(i) Configuration Tables

(j) Common Active Track Buffer

(k) Selected Code Table

(l) Tabular Track Index

(m) Track Number Pointer Table

(n) Temporary Flight Plan Store

(o) VFR/IFR Code Table

(p) Time, Altimeter Setting and ATIS/GSI

(q) Emergency/Radio Failure/Hijack/Suspect Aircraft

(r) Memory Readout

(s) MSAW Geography

3.6.2.1.1.1.18 Minimum Safe Altitude Warning (MSAW) - The contractor shall furnish within the operational program MSAW software as functionally specified in PX-11325, and any revisions thereto and as functionally

updated in mutually agreed upon FAA operational software. The MSAW aural alarm shall operate in the multiprocessing system under normal operational conditions as well as first level backup.

3.6.2.1.1.2 First Backup Single RT & BTL Operational Program - The First Backup Single RT & BTL Operational Program shall operate when the equipment configuration is degraded by 1 IOP and/or 1 MM. Use of this program shall be independent of the particular IOPs and MMs available for program execution. It shall be composed of the same capabilities as the Single Full Capability RT & BTL Operational Program (see section 3.6.2.1.1.1) except for the elimination of the search radar related functions, all on-call programs (e.g., ETG, utility), magnetic tape flight plan processing and the automatic initiation of those tracks without discrete beacon identity codes. In addition, restrict the number of controlled tracks to 130 actively tracked tracks. The total number of tracks (including tabular tracks) does not change. Thus, Radar Input Processing (section 3.6.2.1.1.1.3) and Radar/Beacon Correlation (section 3.6.2.1.1.4) will not be part of the First Backup Single RT & BTL Operational Program and radar tracking in the Radar/Beacon Tracking (section 3.6.2.1.1.1.5) task will not be used. The on-call programs, and the automatic initiation function for the remaining beacon portion of the eliminated sensor will not be part of the first level backup program.

3.6.2.1.1.3 Second Backup Single RT & BTL Operational Program - The Second Backup Single RT & BTL Operational Program shall be an emergency backup to be used only in unusual circumstances. This program shall be a subset of the First Backup Program. Functions shall be deleted to allow some air traffic control capability in the minimum configuration possible. This minimum configuration shall contain 1 IOP and 3 MMs. The following functional items may be deleted from the list in section 3.6.2.1.1.1 (in order of increasing priority): b, c, the radar portion of d, o, g, i, n, j, p, q, and r. Reduced display or track capacity may be allowed if required. The contractor shall submit a proposed functional definition for this emergency backup program for government review following a sizing

analysis. Use of this program shall be independent of the particular IOPs and MMs available for program execution, except for the case of units removed from the system because a specific two IOPs have been removed. This program shall be capable of maintaining at least 100 track files including 75 active controlled tracks.

3.6.2.1.2 Dual RT & BTL Operational Software - Any ARTS IIIA site with two sensors shall use the Dual RT & BTL Operational Programs. There shall be four types of Dual RT & BTL Operational Programs; Full Capability, First Backup, and Second Backup.

The source RT & BTL program for all RT & BTL Operational Programs shall be the same. Through the use of the assembler and the Builder, this source RT & BTL program shall be capable of being assembled off-line into any one of the RT & BTL Operational Programs (the object RT & BTL Operational Programs) specified and placed on a disc suitable for bootstrap loading. Recursive and re-entrant coding techniques shall be capable of being used in both the Multiprocessor Executive and the tasks.

3.6.2.1.2.1 Full Capability Dual RT & BTL Operational Program - The Full Capability Dual RT & BTL Operational Program shall include the same functional tasks as listed in section 3.6.2.1.1.1. In addition, this program shall be capable of accepting inputs from two sensors simultaneously and tracking targets which exist within the area of coverage of both sensors.

To effect proper operation, there shall be a tracking link within the software which shall allow proper controller symbols to be displayed for an aircraft being controlled at one position and being viewed, but not controlled, at another position regardless of the sensor associated with that position. The handoff of an aircraft between controllers associated with different sensors shall be operationally identical to when both controllers are associated with the same sensor.

3.6.2.1.2.2 First Backup Dual RT & BTL Operational

Program - The First Backup Dual RT & BTL Operational Program shall be loaded into main memory and assume control of the system whenever the available equipment configuration allows if the available equipment cannot support the Full Capability Program. Normal configuration for the first is one IOP and one MM less than the full capability.

Use of this program shall be independent of the particular IOPs and MMs available for program execution. This program shall be composed of the same capabilities as the Full Capability Dual RT & BTL Operational Program (see section 3.6.2.1.2.1) except for the elimination of the radar related functions for one sensor. Thus Radar Input Processing (section 3.6.2.1.1.1.3), and Radar/Beacon Correlation (section 3.6.2.1.1.1.4) shall nct be part of the First Backup Dual RT & BTL Operational Program and radar tracking in the Radar/ Beacon Tracking (section 3.6.2.1.1.1.4) task shall not be used for one sensor. The sensor to be excluded shall be determined by the site adaptation data base unless the available equipment forces the choice of sensor.

3.6.2.1.2.3 Second Backup Dual RT & BTL Operational Program - The Second Backup Dual RT & BTL Operational Program shall be similar to the Second Backup Single RT & BTL Operational Program (section 3.6.2.1.1.3).

3.6.2.2 RT & BTL Support Software - ARTS III support software shall be modified and expanded consistent with the ARTS IIIA system environment. Support software shall provide for semi-automated support functions just as the operational software provides for semi-automated cperational functions.

3.6.2.2.1 Assembler - An assembler shall be provided for the system described herein. The assembler shall provide all the capabilities of the existing ARTS III Assembler, as described in PX-6196, and the capabilities prescribed in section 3.6.2.2.1.1 through 3.6.2.2.1.2.

3.6.2.2.1.1 Modified IOP - The assembler shall produce object code for an IOP containing the modifications

specified in 3.5.2.10, as well as for an unmodified IOP. The assembler shall be augmented to generate new instructions and exploit the added IOP capabilities. A capability to assemble the largest operational program on-line in a mode not lower than the first back-up shall be provided.

3.6.2.2.1.2 Program Generation System - The assembler shall be an integral part of the support software system and shall operate on a program generation system configuration. As a minimum it shall consist of:

(a) One IOP

(b) Two 16K Memory Modules

(c) One Peripheral Adapter Module with IMT and TTY

(d) One UNIVAC 9300

(e) Four UNISERVO VI-C magnetic tape units.

(f) A 100 megabyte disc

3.6.2.2.2 Builder - The builder shall provide the capability of loading and linking all the executive modules, tasks, and data bases that make up a unique system program. The builder shall be physically segmented into two sections. The first section shall be generated in IMT bootstrap format and shall include a relative loader, a control routine, an I/O handler for a UNIVAC VI-C Magnetic Tape Subsystem, ASR-37 Teletype, 100 megabtye disc, and UNIVAC 9300 (high speed printer and card reader). The second section shall be generated in relocatable format acceptable for loading by the relative loader. The builder shall be executed in a one IOP configuration and shall, therefore, not need to be coded reentrant. The builder shall require nc more than two memory modules and the use of disc.

3.6.2.2.3 Builder Utility Program (BUP) - The BUP shall provide a convenient, efficient means of building, modifying, and inspecting an organized set of

programs as built by the builder program. BUP shall be used to build system recovery libraries as defined below. BUP shall be a non-resident subset of the builder that shall be loaded into memory only when specifically commanded by an operator. BUP shall be interactive with an operator in direct control throughout all BUP operations. BUP operation shall be terminated by transferring control back to the builder control routine. All BUP operations shall be controlled from the teletype keyboard.

BUP shall operate in a configuration consisting of one IOP and the following peripherals:

(a) Disc

(b) VI-C Tape Subsystem (Minimum of three transports).

(c) 9300 Printer and Card Reader.

(d) ASR-37 Teletype

(e) IMT (alternate)

An optional capability to use the IMT shall be provided so it shall be possible to bootstrap load the absolute formatted portions of the builder from a Disc or VI-C Tape Subsystem. BUP shall utilize these portions of the builder for loading, for communications with the teletype, for communication with the 9300, and for the builder utility functions (e.g., inspect, change, dump, store constant, and assign features).

BUP shall provide the capability to operate without a Disc and thereby generate recovery system libraries (RSLs) entirely on the VI-C Tape Subsystem.

3.6.2.2.3.1 Recovery System Library - An organized set of programs and the recovery module shall be called a Recovery System Library (RSL). A recovery system library shall consist of physical records. The first record shall always be the recovery module. A directory of system programs shall always be the second record. A directory of diagnostic programs shall

always be the third record. System programs and diagnostic/utility programs shall start with the fourth record.

3.6.2.2.4 Continuous Data Recording (CDR) Editor - The CDR editor shall provide printer output of the data written by the CDR extractor (see section 3.6.2.1.1.1.11). The CDR editor shall be capable of operating in any IOP which is physically cabled to the CDR peripherals and with any 16K memory module.

The operator shall have control of the data types and data filters. Data type indicators and filter values shall be input by the operator. It shall function as described in section 3.6.1.2.1 except that search radar replies and search radar targets are allowable data types and the output filters shall include search radar.

3.6.2.2.5 Diagnostic Software

3.6.2.2.5.1 Systems Diagnostics - A system diagnostic/monitor test shall be supplied for the RT & BTL systems. The purpcse of the system diagnostic/monitor shall be to (a) ascertain the operability of eguipment functions associated with the systems and (b) provide a maintenance tool which has the capability of exercising the system to nearly the same degree as the operational program and to isolate problems which may occur under this level of exercise.

The system diagnostic shall be modular in nature. That is any combinaticn of subprograms can be added to achieve the degree of system verification desired. As a minimum the system diagnostic program shall be comprised of the following test subprograms:

(a) Diagnostic Monitor Subprogram

(b) Processor Subprogram

(c) Memory Unit Subprogram

(d) Data Entry and Display Subprogram

(e) Beacon Data Acquisition Subsystem Subprogram

(f) Interfacility Communications Adapter Subprogram

(g) Mass Storage Subsystem Subprogram

(h) Radar Data Acquisition Subsystem Subprogram

3.6.2.2.5.2 Subsystem Diagnostics - The contractor shall supply a separate set of equipment-oriented diagnostic programs which operate "off-line". These diagnostic programs shall include the features necessary to meet the equipment maintainability requirements specified in Section 3.8. As a minimum, diagnostics shall be provided for each of the following system equipment items.

(a) IOP

(b) Memory Module

(c) Peripheral Adapter Module

(d) Disc

(e) Beacon Data Acquisition Subsystem

(f) Radar Data Acquisition Subsystem

(g) Data Entry and Display Subsystem

(h) MSP

(i) Central Memory Access

(j) MDBM

(k) IMT

(l) TTY

(m) UNISERVO VI-C

(n) 9300

The diagnostics shall provide the complete capability of testing, monitoring, and evaluating all logical/programmable functions within the module under test. The diagnostics shall detect 95 percent of all single, non-intermittent Printed Circuit Board (PCB) failures and provide isolation of 75 percent of those malfunctions to an average of three printed circuit cards of any type. (This assumes a PCB size of 3 inches by 4 inches. For larger PCBs, isolation shall be to a single PCB.) In equipments where cards are not employed, malfunctions shall be isolated to a group of replaceable circuit elements equivalent to the logic contained on three average printed circuit cards. This isolation shall be accomplished using a combination of automatic and manual procedures.

A capability for manual call up of diagnostics shall be provided to be used in an off-line mode. This means that no operations shall occur in the module under test at the time the module diagnostic is being executed. Each program shall assume that all modules necessary for test use, except the module under test, are in proper operating order. All execution of these diagnostics shall be from the appropriate IOPs indicator panel. The manual call diagnostics shall be manually loaded from magnetic tapes.

3.6.2.2.6 Debug Aids - The debug aids are programs which may be used in the program development and program maintenance efforts to assist in the isolation of program related problems. The debug module is a removable part of the executive program. The other debug aids described below are self contained programs which may be loaded with the operational program.

3.6.2.2.6.1 Debug Module - The debug module shall be a removable segment of the executive program intended for use at a support facility. The debug module provides the programmer with the tools for the integration and checkout of a program task. The debug module shall provide the following functions:

(a) Software Breakpoint - This function shall enable or disable a breakpoint operation. When a processor reaches a software

breakpoint, the processor shall be placed in a suspended state. It shall be possible to request any debug function following a breakpoint hit.

(b) Program Segment Timing - This function shall determine the elapsed time between the execution of two specified timing breakpoints and provide output timing statistics on the printer.

(c) Snap Dump - This function shall output immediately the contents of a limited area of memory whenever a processor reaches a specified memory address. Output shall be routed to printer, teletype or magnetic tape.

(d) Change Memory - This function shall change the content of a specified memory word to the data value specified by the user. The old and new data values shall be printed following the change.

(e) Dump Memory - This function shall search a specified area of memory for a selected bit configuration and print the address of each find.

(f) Suspend Processor - This function shall cause the requested processor(s) to enter a suspended state with task processing discontinued. A suspended processor shall remain available for processing of other debug requests. A suspended processor shall resume processing upon command.

(h) Register Dump - This function shall output the content of pertinent registers at a selected breakpoint.

(i) Processor History - This function shall collect and print history data including executive service requests, interprocessor interrupt type executed, planned tasks executed, popup tasks executed, processor

number, and realtime clock.

3.6.2.2.6.2 Miscellaneous Debug Aids - These debug aids shall be capable of being included in the RT & BTL operational tasks and the executive program. These debug aids shall be as follows:

(a) Print Memory - Print the contents of the memory area specified by a start and end address in the processor registers. Printout is on the 9300.

(b) Write Bootstrap Format - This program shall write the contents of the specified area of memory onto the IMT in boctstrap format.

(c) TTY Print - This program shall print the contents of the specified area of memory on the TTY.

(d) Search Core - This program shall search the contents of the specified area of memory for a particular masked value.

3.6.2.2.7 Enhanced Target Generator Scenario Tape Builder - An enhanced target generator scenario tape builder shall be provided. The off-line tape builder shall provide all of the functional capabilities of the existing ARTS III tape builder.

3.7 Reserved

3.8 System Availability, Reliability and Maintainability - The contractor shall plan and implement a reliability and maintainability program in accordance with MIL-STD-785 and MIL-STD-470, except as modified herein, to meet the requirements of this specification and to meet the detailed reliability, maintainability, and availability requirements specified herein. The ARTS IIIA System reliability shall be such that, in conjunction with achievement of the maintainability requirement, the system availability requirements shall be met. Hardware modules shall be designed, constructed and tested in accordance with FAA-E-2591a. Each system shall be

designed to be maintained with a minimum of external test equipment and use of standard hand tools. Corrective maintenance shall be effected by replacement of defective module(s) with subsequent repair of the defective module(s) off-line. Requirements for adjustments shall be kept to a minimum. The design, to the maximum extent possible, shall maximize interchangeability, minimize the need for adjustment and attempt to limit the variety of modules, and PC boards, used in the system.

3.8.1 Applicable Definitions - The reliability, availability and maintainability definitions used in this specification are those of MIL-STD-721, with the additions or modifications as noted below:

(a) Mean-Time-to-Repair (MTTR) - The mean-time-to-restore to an operational condition a function or equipment that has failed. The function or equipment may be restorable by corrective maintenance repair, substitution by module or PC board replacement.

(b) Availability - The probability of specified operability at any time over the service life of the system. Allowed preventative maintenance times need not be counted as unavailable periods or down-time, provided the requirement to reach an operable state as defined herein is always met. Availability is the quotient of the total system up-time divided by the sum of the total system up-time and down-time.

(c) Service Life - Intended useful life of system. Short life items are replaced on a scheduled basis under the preventative maintenance plan. For the ARTS IIIA System, the service life is at least ten (10) years.

(d) Module - That component part, assembly or element as defined by the contractor and approved by the government and designated as the first level of maintenance required to

repair or restore the system function to normal and provide the service intended.

3.8.2 System Failures - ARTS IIIA System failures fall into two categories, functional failures and equipment failures. Both categories can be chargeable as downtime in determination of system availability, system MTBF, or both.

3.8.2.1 Functional Failures - Functional failures are those failures which: (1) cause either the complete or partial loss of a functional capability required by this specification; (2) cause degraded operation of a function by deviating from the performance requirements of 3.10; or (3) cause the erratic, erroneous, transient or unintended operation of any function. A functional failure shall not be declared during a normal 10 second recovery operation.

3.8.2.2 Equipment Failures - Equipment failures are rack, drawer, module, card, or part failures whose impact upon the system functions may vary from a minor maintenance action to catastrophic. For example, the failure of a BDAS whose redundant unit takes over automatically, with no loss of a function, is only an equipment failure and does not impact on system availability. However, the random or catastrophic failure of a module that effects the data presented at one or more displays is both an equipment and functional failure, and therefore impacts on system availability.

3.8.3 Reliability and Maintainability (R & M) Program

3.8.3.1 Program Plan - The contractor shall prepare and submit for approval a R & M program plan in accordance with MIL-STD-785. This program plan shall be submitted with the technical proposal and updated within sixty (60) days after award of contract. This program plan shall include software reliability.

3.8.3.2 R & M Management - The contractor shall have one clearly identified organizational element which will be responsible for the planning and management of the R & M program specified herein and for insuring its

effective execution. The individual designated as head of this management organization shall have the necessary authority and resources, and report at a level having full responsibility for the contract effort to enable him to implement and enforce the requirements specified herein.

3.8.3.3 Program Tasks - The R & M program shall include the elements of MIL-STD-785 with the following tasks modified as indicated in the paragraphs hereunder.

3.8.3.3.1 R & M Design Reviews - The program plan shall include design reviews of the system, its functions and equipment. They shall include a preliminary design review and a critical (predesign release to manufacturing) design review. Other reviews may be called as necessary either by the contractor or the Government. The Government shall participate in all reviews. These reviews shall be scheduled as part of the ARTS IIIA System design reviews. The contractor shall notify the Government of design reviews at least thirty (30) days prior to their occurrence and submit complete data packages at time of notification. Items to be covered as a minimum in the conceptual and critical reviews are the tasks that follow.

3.8.3.3.2 R & M (Availability) Apportionment Task - The contractor shall apportion the availability requirements of each constituent component of the ARTS IIIA System. Constituent components shall be, as a minimum, considered to be modules encompassing singular functions or operations, i.e., Memory Module, Input-Output Processor (IOP), power supply module, control unit, printed circuit board and software program. They shall be such that they will be in agreement with the reliability and maintainability requirements specified herein. These apportionments shall be submitted in the technical proposal and shall be in the availability requirements of the contractor's design. Any changes shall be submitted to the Government for review and approval. Approval of these data does not release the contractor from the requirement of meeting the system availabilities and detailed R & M requirements specified herein.

3.8.3.3.3 R & M Modeling Task - The ARTS IIIA System shall be reliability and maintainability modeled. The contractor shall identify critical items or paths whose failure will either cause system or subsystem failures, major performance degradation, loss of a function, marginal operational conditions or departures from the R & M Requirements, as specified herein. From the R & M predictions and the R & M models, together with system operational loading, critical elements shall be highlighted with emphasis upon means of sustaining operation, via techniques such as redundancy, manual patches, and over-capacity, in the event of failure. Note, however, that the ability to sustain or reinstate operation in this manner shall not prevent the incident from being classified as a failure. Preliminary estimates for each of the models shall be submitted with the proposal and shall be updated as necessary to reflect system changes as they may occur. A final version containing all system details shall be submitted and included as part of the critical design review data package, and shall be subject to the review cycle as specified. The R & M Modeling shall include the following three (3) configurations:

(a) The Mass Storage Subsystem (MSS) of a BTL system.

(b) Radar Tracking and Beacon Tracking Level (RT & BTL) system with MSS using a single and dual radar and beacon sensor input.

(c) Beacon Tracking Level of a RT & BTL system.

3.8.3.3.4 Failure Modes, Effects and Criticality Analysis (FMECA) Tasks - A FMECA shall be performed. This analysis shall be conducted down to the level of modular replacement in normal maintenance (e.g., printed circuit card, power supply module). For each such replaceable item, the dominant modes of failure shall be determined. Based upon these modes of failure, the effect on subsystem and system performance shall be ascertained. The analysis results shall be employed to evaluate and change the reliability maintainability-availability (RMA) model, if necessary. The task shall be completed and reviewed at the

critical design review and used in preparation of the maintainability demonstration tasks. A preliminary analysis utilizing the reliability model shall also be submitted ninety (90) days after contract award and updated thereafter as design or system changes occur. The FMECA will be reviewed as part of each design review. Any further changes in the FMECA shall be submitted at least sixty (60) days prior to initiation of the reliability or maintainability demonstrations specified in Section 4.0.

3.8.3.3.5 Parts Control Task - The contractor shall establish a parts control effort that shall, to the maximum extent possible: (a) assure the utilization of standard parts or assure proper useage application of commercially available off-the-shelf equipment permitted by FAA-E-2591a; (b) assure the suitability of nonstandard parts that are subject to Government approval prior to being incorporated in the system design.

3.8.3.3.6 Failure Reporting, Analysis and Corrective Action Task - The contractor shall establish a closed loop system for reporting all failures. The level of equipment (e.g., circuit board or module) both manufactured and subcontracted items, for which the contractor proposes to maintain failure records shall be included in the technical proposal. As a minimum, failures occurring from the time of final manufacturing unit test forward to the end of the warranty period shall be reported with analysis and results. Analysis and results of failures will not be required on commercially available off-the-shelf equipment. The contractor shall analyze each failure to determine its cause. Each analysis shall include development of corrective action to prevent reoccurrence. Failure reports shall be maintained by the contractor to which the Government will have unlimited access. A copy of any individual report shall be provided to the Government on request. Off-the-shelf item failures shall be handled on an as required basis. Whenever a significant problem becomes evident, the analysis and corrective action of that problem shall be made.

3.8.3.3.7 Reliability and Maintainability

Demonstration - Demonstration of achievement of RMA requirements shall be accomplished by means of R & M demonstration tests as described in Section 4. A summary report of failures shall be submitted so that trends and patterns, can be discerned. The failure summary shall also include the relevancy of the reported failures. Sufficient data shall be included in the summaries to verify the relevant/non-relevant classifications.

3.8.4 R & M Design Parameters

3.8.4.1 System Recovery After a Power Failure - In the event of a power failure or out-of-tolerance transients of line voltage, the system shall be designed to protect itself from damage and shall prevent loss or alteration of system stored data. When normal power levels have returned, previously stored data shall be displayed, and all functions shall automatically, without operator action or intervention, be made available to the controller within 10 seconds after resumption of power and the disc drives are up to speed. Power failures shall not result in the loss of any data stored in memory prior to a power failure.

3.8.4.2 AC Power Transients - The following AC power transient conditions shall not be considered a power failure and the equipment shall continue

in normal operation; using nominal AC input power of 120 VAC at 60 Hz.

(a) Transients that cause the line voltage to decrease to less than 90 percent of nominal when:

1. The transient is 8 milliseconds or less in duration and the line voltage is 95 to 110% of nominal immediately prior to the transient, or

2. The transient is 4 milliseconds or less in duration and the line voltage is 90 to 95 percent of nominal immediately prior to the transient.

(b) Transients that cause the line voltage to increase to more than 110 percent of nominal but less than 130 percent when the transient is 17 milliseconds or less in duration.

(c) Transients that cause the line voltage to vary by plus or minus 10 percent from nominal for any duration of time.

(All reference to line voltage is line to neutral)

An interruption (AC voltage has gone outside the range of 90 to 110 percent of nominal) may start at any time during a 60-cycle period with the requirements above still applicable.

3.8.4.3 System Maintainability - Design of the hardware and software shall provide a system capable of having faults isolated to the correct unit in an average of not more than five minutes. The contractor shall discuss in the proposal the maintenance concept, tailored to MIL-STD-470, and include the following system maintenance parameters:

(a) Cost tradeoffs and reliability considerations involved in the application of both preventive and corrective maintenance.

(b) Number and skill level of maintenance personnel and type of specialized training required to maintain the system.

(c) Level of the diagnostic support.

(d) Type of printed circuit board malfunction isolation and repair technique.

(e) On-line system performance monitoring.

3.8.4.4 Maintenance Concept - The maintenance concept shall be to localize a failure through use of system monitoring features, and software and hardware maintenance features and to replace the failed module elements or pluggable unit from site spares. The actual repair of the defective or failed item shall be

accomplished off-line at the convenience of maintenance personnel.

3.8.4.5 Subsystems Isolation - System design shall be such that component failure within any subsystem shall not cause equipment or functional failure in another subsystem. As an example, the Continuous Data Recording (CDR) function is defined as a subsystem; any functional or equipment failure occurring within the CDR subsystem shall not affect the functional capability of other subsystems.

3.8.4.6 Modification of Basic ARTS III GFE Equipment or Subsystems - Modifications to existing GFE equipment or subsystems that are required by the contractor's design to meet the ARTS IIIA System requirements specified herein shall in no way degrade performance or reliability of modules or components within the subsystems that are not modified by the contractor.

3.8.5 System Reliability Parameters - The ARTS IIIA System shall meet the reliability, maintainability and availability (RMA) specified herein when operated in a 90 degree Fahrenheit environment. Incandescent lamp failures may be exluded in determining system MTBF's, however, panel lamps shall be replaceable from the front of equipment cabinets without need of special tools. Generalized functional models of the typical subsystems of the ARTS IIIA System configuration are shown in Figures 3-1, 3-2, and 3-3. These figures are included here for information purposes only.

3.8.5.1 System Availability

3.8.5.1.1 RT & BTL Capability - The availability of the RT & BTL capability shall not be less than 0.999 with a M.U.T. of at least 770 hours. The RT & BTL capability is considered available if not more than 2 simultaneous DEDS failures have occurred. The Continuous Data Recording Function is not required.

3.8.5.1.2 BTL Capability - The RT & BTL system shall be designed such that in the event of a single equipment module failure the system can be manually reconfigured to provide a BTL capability that is

equivalent to the existing ARTS III BTL System. The availability of the BTL capability shall not be less than 0.999999 with a M.U.T. of at least 10^6 hours. A BTL capability is considered available if not more than 2 simultaneous DEDS failures have occurred. The CDR function will not be required.

3.8.5.2 Corrective Maintenance - Equipment failures shall have a Mean-Time-to-Repair (MTTR) of thirty (30) minutes with a maximum time not exceeding one (1) hour.

3.8.5.3 Reliability - Reliability shall be in accordance with FAA-E-2591a.

3.8.5.4 Maintainability - Maintainability shall be in accordance with FAA-E-2591a.

3.9 Test Equipment

3.9.1 Special Tools and Test Equipment - The terms special tools and test equipment is defined as those tools and test equipment not carried as a standard line by the contractor or another manufacturer. All special tools and test equipment necessary for the installation, repair, adjustment, test and maintenance of the system specified herein, not readily available on the open market, such as alignment wrenches, testing devices, jigs, special purpose test cables, and circuit card extenders, shall be supplied with the equipment. The contractor shall submit for Government review a complete list of special tools and test equipment, the application of each, and unit and/or component for which it is required. This shall be submitted prior to fabrication or procurement of any specialized tools and test equipment for use at Government facilities. The design of the equipment shall be such as to permit the use of standard tools and test equipment in so far as practicable.

3.9.2 Standard Test Equipment - The contractor shall provide a list of standard test equipment which will be required as a minimum to maintain the system. The information in this list shall include but not be limited to the following for each item of test equipment:

(a) Intended use, such, measure voltage, or count pulses.

(b) Ranges required.

(c) Accuracy requirements.

(d) Special parameters, such as, short term drift, long term stability, and temperature requirements.

(e) At least three suggested sources of supply.

(f) Estimated cost (catalog prices) for single units and quantities.

(g) Estimated frequency of use.

3.10 System Performance Requirements

3.10.1 General - The system shall meet all the performance requirements in this section simultaneously when perforing the operational functions required by this specification. These performance requirements shall be satisfied when operating under the traffic loads and environmental conditions specified in the contract. Adherence to the performance requirements shall be measured in the tests described in section 4. Performance requirements are defined for the following functional areas:

1. Target detection/declaration

2. Tracking

3. System throughput/response

4. Continuous data recording

5. Display data

6. Failure recovery/system reconfiguration

3.10.2 Radar Target Detection - The target detection function shall meet, and be tested to, the following

performance criteria.

3.10.2.1 Final Detection Performance - The detection window used in the final detection process shall sample the returns received at the same 1/16 N.M. range cell for as many sweeps as contained in the beamwidth of the antenna pattern of each radar. The sample size (sweep/beamwidth) shall be a parameter between 8 and 48 and be set for each site. The false alarms generated by radar noise input to the window (no clutter, no targets) shall conform ($\pm$10%) to equation:

$$P_{FA} = P_N(1 - P_N) \left[\frac{(N - 1)!}{(T_L - 1)!(N - T_L)!} \right] P_N^{(T_L - 1)} (1 - P_N)^{(N - T_L)}$$

Where N = sample size (sweeps per beamwidth)

P_N = probability of noise pulse in any range quantum (as defined in FAA-E-2591a, Paragraph 3.1.17.2.3, Log Normal Rank Order Quantizer)

T_L = target leading edge threshold, which shall be a site adaptable parameter between 4 and 24

P_{FA} = probability of a false alarm.

3.10.2.2 Center Azimuth Estimation - Target center azimuth estimation shall have a standard deviation of no greater than 0.2 degrees for a target that is 6 db stronger than noise.

3.10.3 Tracking - The performance of the tracking module shall be defined and measured within two areas:

(a) tracking capability, and

(b) tracking quality.

3.10.3.1 Tracking Capabiliy - The tracking module

shall track all types of aircraft under varying conditions of traffic density and environment. In this context, "type" refers to aircraft with discrete-coded beacon transponders, non-discrete coded transponders, and no transponders. Tracking shall be maintaned during periods of missing returns, the duration of the period being controlled by a variable site parameter.

Finally, for dual radar/beacon systems, when one sensor fails, tracking shall be maintained in the area overlapped by both sensors.

3.10.3.2 Track Quality - Track quality is expressed in terms of track reliabiliy and track accuracy.

3.10.3.2.1 Track Reliability - Track reliability is a measurement of the ability of the tracking system to follow an aircraft under various conditions of aircraft maneuver and environment, and maintain its identity. There are a number of measures of track reliability:

(a) Track Correlation Ratio: The ratio of the number of track scans in which all tracks correlated to the total number of track-scans in which those tracks were being tracked. The Track Correlation Ratio requirements shall be as follows:

Discrete Beacon Aircraft: Greater than or equal to 95% for both straight and level flight and maneuvers for all speeds when the discrete blip/scan ratio is greater than or equal to 95%.

Non-discrete Beacon and no Beacon Aircraft: $\leq$90% for both straight and level flight and maneuvers when the discrete blip/scan ratio is $\geq$95%.

(b) Track Loss Probability: The Track Loss Probability is the probability that a track will be completely disassociated with the data (tabular coast list) for one or more scans. When the individual beacon and search blip/scans are greater than or equal to 95%

and the range and azimuth standard deviations are .04 nm and 0.23 degrees respectively, the track loss probability shall be as follows for all speeds less than or equal to 400 knots:

Discrete Beacon Aircraft: No track loss for both straight and level flight and non-military maneuvers.

Non-Discrete Beacon and No-Beacon Aircraft in the clear: Less than or equal to 1% for straight and level flight; less than or equal to 5% for non-military maneuvers.

(c) Track Swaps: The track swap requirements shall apply to a variety of maneuvers of two or more aircraft including shallow (less than or equal to 10 degrees) cross-over and overtake patterns. Track swaps shall include erroneous identity in the data block as well as track loss under a swap opportunity. The requirements shall be as follows:

Discrete Beacon Aircraft (at least one of the pair): No track swaps.

Non-Discrete Beacon and No-Beacon Aircraft (both aircraft): Less than or equal to 5% of the total of all swap opportunities.

3.10.3.2.2 Track Accuracy - The output of the tracking module shall meet the followng accuracy requirements:

(a) Straight and level flight: For straight and level flight, track accuracy is expressed in terms of the standard deviation (sigma) of the error between the true value, and the calculated value. For the standard deviations given below, the aircraft slant range is between 15 and 50 nautical miles and the aircraft speed is 150 knots.

Position Error: Less than or equal to 300

feet.

Speed Error: Less than or equal to 12 knots.

Heading Error: Less than or equal to 5 degrees.

(b) Maneuvers (Dogleg): For maneuvering aircraft in a standard rate turn (3 degrees/sec if speed less than 200 knots, 1/1/2 degrees/sec if speed is greater than or equal to 200 knots), track accuracy is expressed in terms of the expected value of the error between the estimated value and the true value. For maneuvers, the significant parameters are RMS errors and the time it takes for the RMS error to be reduced to the straight line error when the aircraft returns to straight line flight. For the values given below, the aircraft slant range is between 15 and 50 nautical miles, the aircraft speed is 150 knots, and the dogleg angle is 90 degrees. The requirements shall be:

		Return to Straight Line Performance
RMS Position Error:	600 feet	10 scans
RMS Speed Error:	55 knots	10 scans
RMS Heaing Error:	21 degrees	8 scans

These values apply to beacon equipped aircraft and non-beacon aircraft in the clear. The target report quality shall be as specified under Track Loss Probability in Section 3.110.3.2.1.

3.10.4 System Throughput/Response

3.10.4.1 Response to Video Signals - The time to display symbology after a video signal is received from the radar cr beacon set shall be no greater than 1.2

seconds for controlled tracks and 2 seconds for uncontrolled tracks.

3.10.4.2 Response to Controlled Aircraft Actions - The time to process the keyboard entry, complete the entry requirements and display the appropriate alphanumerics shall be no greater than 1.2 seconds after the completion of the keyboard entry.

3.10.4.3 Preview Character Display - Thetime to display a character in the preview area shall be no greater than 0.2 seconds after the character entry.

3.10.4.4 Response to Data Readout Requests - The time to display the requested data shall be no greater than 0.5 seconds after the keyboard entry.

3.10.4.5 Data List Relocation - The time to complete the task shall be no greater than 1.2 seconds after the keyboard entry.

3.10.4.6 Respnse to Uncontrolled Aircraft Action - The time to process the keyboard entry, complete the entry requirements and display the appropriate alphanumerics shall be no greater than 1.2 seconds after the completion of the keyboard entry.

3.10.4.7 Response to Quick Look Actions - The response time for a quick look request shall be no greater than 1.2 seconds.

3.10.4.8 Response to Automatic Offset - The resonse time for an automatic data block offset shall be no greater than 1 scan time after the data block conflict occurs.

3.10.4.9 Response to Trackball - The response time for trackball position symbol movement shall be no greater than 0.25 seconds after the trackball has been moved.

3.10.5 System Capacity - RT & BTL systems shall be capable of achieving the performance requirements of this specification when processing the system load specified below:

1. Number of true radar targets, each sensor: 300/scan

2. Number of true radar targets in one sector (11.25 degrees), each sensor: 25

3. Number of false radar targets each sensor, in addition to the number of radar targets of item 1: 50/scan

4. Number of beacon targets (all Mode C) each sensor: 130/scan

5. Number of beacon targets in one sector (11.25 degrees), each sensor: 15

6. Fruit rate (undefruited input) each sensor: 2000/sec

7. Full Data Blocks each display: 20 (14 character tag)

8. Limited Data Blocks, each display: 15 (3 character tag)

9. Tabular Messages, each display: 15 (10 characters)

10. Controlled Single Symbols, each display: 100

11. Uncontrolled Single Symbols, each display: 100

12. Displays, each site: 14

13. Keyboards, each site: 34

14. The ratio of controlled to uncontrolled aircraft is 2:1

The above data shall be used as a guide for the design of the software architecture. System sizing shall be determined by environmental and traffic loads for each site whih will be defined in the contract.

3.10.6 Display Data - The RT & BTL systems shall have the capability of presenting simultaneously on each DEDS the display load shown in TABLE 3.10-1. Under these load conditions the Display Buffer Memory shall meet a date output rate such that the refresh rate shall be 24 Hz or higher.

3.10.7 Automatic Failure Recovery/System Reconfiguration - Automatic failure recovery shall occur in the following situation:

1. Failure within the data processing subsystem (see section 3.4)

2. Failure of one unit of a redundant pair; i.e., BDAS

3. Failure in one channel of a unit with dual channel interconnection to the data processing subsystem.

3.10.7.1 Data Processing Subsystem Failure Recovery - Recovery from a power failure shall use the same NDRO/Recovery Module logic as other failures which trigger the scatter interrupt. Whenever power on a processor drops below a given level, the processor issues a scatter interrupt and reverts to a Master Clear state. If this processor was the only one that suffered a power loss, the system shall recover without including it in the system resources. If the power failure affected all processors, they would all reach the Master Clear state and remain there until power exceeded a given threshold. When a processor exceeds this threshold, it again generates a scatter interrupt and the recovery process begins. Not all processors will have power restored simultaneously and hence, a series of scatter interrupts shall be generated. When the last of the series of scatters has been generated, the recovery logic commences in a normal fashion. The NDRO program does the preliminary processor and memory resource evaluation. The disc subsystem shall require a certain amount of time for the drives to reach normal speed and position the read/write heads. After the disc is operable, the recovery module is loaded and the recovery process described in section 3.4.2.5

DATA	DISPLAY TYPE 1, II
FULL DATA BLOCKS	24
LIMITED DATA BLOCKS	100
SINGLE SYMBOLS	50
TABULAR LINES	15

FULL DATA BLOCK	CONSISTS OF TARGET SYMBOL, LEADER, AND 14 CHARACTER TAG
LIMITED DATA BLOCK	CONSISTS OF TARGET SYMBOL, LEADER, AND 3 CHARACTER TAG
SINGLE SYMBOL	CONSISTS OF TARGET SYMBOLOGY
TABULAR LINE	POSITION ADDRESS AND 10 CHARACTERS

REFRESH RATE: 24 Hz MINIMUM with ten displays on a single IOP being refreshed concurrently with the above data display model in the available digital refresh time.

TABLE 3.10-1

DATA DISPLAY MODEL

continues. Automatic recovery and reconfiguration from a DPS failure shall not exceed 10 seconds when using the disc subsystem and the disc drives are up to speed.

3.10.7.2 Redundant Unit Recovery - When one unit of a redundant pair has failed, (e.g., he BDAS) recovery and reconfiguration to the alternate unit shall require no more than 250 milliseconds.

3.10.7.3 Dual Channel Recovery - When failure has occurred in one channel of a unit with a dual channel interconnection to the data processing subsystem, recovery and reconfiguration to the alternate channel shall require no more than 250 milliseconds.

3.11 System Site Installation and Cutover

3.11.1 Pre-installation Planning - The contractor shall conduct on-site inspections to become familiar with the different environments that will be encountered during installation and checkout of each system.

The facilities to be visited will be jointly agreed to by the Government and contractor. Government representation will be available during these site inspections, and access to equipment and control rooms as well as to other TRACON associated areas under Government jurisdiction will be arranged by the Government. If available, copies of drawings covering floor plan layouts, AC power, duct or overhead ladder installations of the control and equipment rooms of the sites inspected will be made available to the contractor during these inspections.

3.11.1.1 Installation Planning Report - The information contained in the report will be used by FAA field organizations and facilities to prepare the sites for system delivery and follow-on installation and checkout activities. As a minimum, the report shall contain the following general and typical information:

(a) System block diagram with a short narrative general description of the functional capabilities and hardware subsystems.

(b) Typical floor plan layouts for control and equipment rooms. Information on equipment placement limitations, e.g., maximum distances between equipment comprising the system or new equipments and equipments already in place, shall be included.

(c) Detailed physical description of the equipment including physical size, weight, clearance factors, ventilation or air conditioning requirements, cable entry and exist features.

(d) Cable and duct/overhead ladder requirements. This section shall include such items as information on subsystem cable interconnection requirements, system cable connections to existing equipment, type and quantity of cables to be used.

(e) Power requirements. Information on size and type of power cabling to be used, type and size of required Government furnished power panels, shall be included.

(f) System and equipment grounding requirements shall be stated.

(g) Any other technical or general information that will be required for Government field organizations in order to properly prepare a site for installation activities and which should be considered for proper installation, operation and maintenance of the equipment.

3.11.1.2 Government Prepared Preliminary Installation Plan - The contractor shall visit five mutually agreed upon ARTS IIIA sites. Information gained from these trips shall be used to assist the contractor in the preparation of a typical site planning report. Based on the contractor prepared typical site planning report, the Government will prepare a site by site preliminary installation plan and submit this to the contractor for review. This preliminary plan will cover such items as:

(a) Floor plan drawings showing each piece of equipment in the equipment rooms and all signal cable ladders and/or ductwork for signal cables between equipments.

(b) Cable routing diagram or cable routing information showing proposed cable routing and estimated length of cable runs between equipment.

(c) Power distribution diagram showing the circuit breakers and sizes to be installed for each piece of equipment as specified in the typical site planning report.

(d) A system grounding diagram showing the various ground cables that are to be installed and connected to the equipment as specified in the typical site planning report.

(e) Equipment delivery information such as elevators, ramps, doorways, hallways, etc.

(f) Any other general information mutually agreed to between the Government and the contractor.

These preliminary installation plans will be submitted six months prior to scheduled system delivery at a particular site to permit contractor review and still allow a minimum of five months for actual site preparation work.

Prior to actual site preparation work, the contractor shall inspect the site and review with the designated FAA representative all installation and site preparation plans to ensure that it conforms with contractor requirements. Cable length and other necessary installation materials shall be determined by the contractor during this site survey.

An inspection of the prepared site shall be made by the contractor 10 days prior to equipment deivery. A representative of the Government shall be on site at this time. During this visit, the contractor shall

check all site preparation work performed and determine if any additional tasks are required prior to equipment delivery.

3.11.2 Installation and Cutover - The ccntractor shall provide a system cutover plan for the testing and acceptance of the hardware and software required to implement the functions described in this specification.

3.11.2.1 Requirements - The installation and cutover task shall be planned to minimize disruption of the present Beacon Tracking Level capability at ARTS III sites. Specifically, the installation tasks shall not cause the loss of the Beacon Tracking Level capability for more than six consecutive hours. Any tasks requiring the shutdcwn of the BTL capability shall be performed during the hours of minimum airport activity.

The installation and cutover tasks shall be planned to provide a modularly phased sequence of installation testing.

3.11.2.2 Installation and Cutover Sequence of events for the installation and cutover task.

(a) Government furnished preparation of sites per the mutually agreed to site installation plan.

(b) Contractor installation and checkout of interim hardware/software required to provide existing site ATC capability.

(c) Confidence testing of interim system using existing system as backup.

(d) Cutover to interim system.

(e) Required modification and integration of existing modules/subsystems.

(f) Testing of entire system including confidence runs using interim system as backup.

(g) Site Operational System Test and Acceptance.

(h) Operational Readiness Demonstration of entire system.

(i) Certification of system and cutover of operational status.

3.12 Documentation - The contractor shall provide all necessary services and material to develop and deliver documentation in the quantities and at the times specified by the contract schedule.

3.12.1 System Design Data - The design data submission shall be organized to reflect the contractor's approach to the total system design. This submission of design data shall not be used to produce modifications or alternatives to details of this specification or a change in the scope of the contract. The design data shall include all elements of the equipment to be supplied by the contractor under the terms of the contract, as detailed by this specification and any addenda thereto, together with all interfaces with other equipment. A summary of equipment operational characteristics shall be included.

3.12.1.1 Block Diagram - A complete set of equipment block diagrams shall be provided by the contractor. The block diagrams shall show the general operational, electrical, and physical relationships of the equipment elements.

3.12.1.2 Information Logic Flow Diagrams - The contractor shall provide complete equipment information logic flow diagrams. These diagrams shall show the detailed logical, operational and functional relationships of the equipment elements. Symbology used in these diagrams shall be fully explained in the basic document.

3.12.1.3 Input/Output Details - The contractor shall provide data which consolidates all equipment interfaces and input/output characteristics. This shall include: transmission line characteristics, signal characteristics and limits, timing diagrams,

message structure and formats, and power requirements. This data shall include all major intra-system as well as external system interfaces.

3.12.1.4 Computer Program Design Data - A complete document of the program organization and design data, subprogram description, external data formats, and internal data formats shall be furnished. This document shall provide overall information about the total computer program. The design data shall indicate the partitioning of the functional requirements into logically related subsets, which are identified with specific subprograms. For each subprogram, a discussion of performance requirements, including estimates of program timing and core storage requirements shall be provided.

3.12.2 Software Documentation - The contractor shall provide operational and support program coding specifications, computer program functional specifications and operator manuals for both the RT & BTL system and the existing BTL system to which CDR has been added.

3.12.2.1 Program Coding Specifications - The program coding specifications shall include detailed descriptions of the program operations for all program and subprogram paths, descriptions of all tables including formats, program listings and flow charts in sufficient detail to permit modifications to the program by appropriately trained Government personnel.

The coding specifications shall be supplied for the RT & BTL system and the CDR portion of the existing BTL system.

3.12.2.2 Computer Program Functional Specifications (CPFS) - The contractor shall provide a complete set of CPFSs similar in detail and content to the CPFSs which exist for the current BTL system (NAS-MD-602 through NAS-MD-613). A preliminary set of CPFSs shall be provided at the time of submission of the system design data.

3.12.2.3 Operator Manuals - For the RT & BTL system,

the contractor shall provide operator manuals which include detailed descriptions of operating controls in the data processing subsystem, start/restart instructions for the software, instructions for gaining access to any part of the software, use of the assembler, use of software debug modules, and any other data relevant to operation and checkout of the software.

For the existing BTL system, amendments shall be provided to existing operator manuals to include the CDR capability.

3.12.3 Test Documentation

3.12.3.1 Test Plan - The contractor shall provide a recommended test plan for both factory and site tests at the module, subsystem and system levels for review and approval by the Government. The objective of this plan will be to show how the contractor will demonstrate compliance with the performance requirements of this specification. The Government will review, approve, and/or direct necessary changes to the test plan as specified in the contract. The contractor shall incorporate such changes and resubmit the final test plan 60 days prior to any equipment tests.

3.12.3.1.1 Test Plan(s) Content - The test plan(s) shall be comprehensive, including all details necessary to assure that test procedures and testing will satisfactorily demonstrate equipment, software, subsystem and system compliance with all requirements specified herein.

The test plan(s) shall include, as a minimum the test description and its purpose. The description shall include a block diagram showing the system configuration and interfaces, the basic test approach and a description of what is to be tested.

The test plan shall provide the information required for subsequent preparation of the test procedures.

The test plan shall provide the information required

for subsequent preparation of the test procedures.

3.12.3.1.2 Test Schedule - The test plan shall contain a contractor proposed schedule for each test. The Government reserves the right to witness any or all tests conducted in accordance with the approved test plan.

3.12.3.1.3 Test Plan Amendments - If, during a test, the test methods or parameters, as agreed to by the Government, are found to be inadequately specified, they shall be amended and further approval by the Government obtained.

3.12.3.2 Test Procedures - The contractor shall provide all test procedures and/or scripts to be used during the conduct of a test. These procedures shall include all test record forms to be used as test data sheets, test operator logs, and reports. The test procedures in addition shall include:

1. Designation of all inputs that are required to test each function.

2. Test output records including a description of required outputs, the types of equipment used to observe or provide the outputs.

3. A complete time sequenced schedule of events.

4. A list and description of each software program to be used, including the total running time for each program. The description shall include the format and contents of each type of message output and of any printouts or records to be maintained.

5. A detailed description of analysis or combination of analysis and test results which may be offered in lieu of testing, where complete test results may be difficult or impractical to obtain.

These documents shall be provided by the contractor and submitted for review 30 days prior to the scheduled

performance of a test as specified in the contract.

3.12.3.3 Test Reports - Upon conducting the applicable tests in accordance with the approved test plan, the results shall be recorded for submission to the FAA within 30 days following the completion of the test.

The test report shall contain a complete description of the test results and as a minimum, ccntain the information specified below:

1. Indicate the performance of each equipment under test and whether it meets the system limits.

2. Functions that were tested.

3. Information asto whether the results of the test are in agreement with the required reliability of the unit or system.

4. The quantity and type of spare parts needed to correct the errors or malfunctions.

5. A record of any engineering changes found necessary to correct design deficiencies.

3.12.4 Index of Drawings and Technical Memoranda - The contractor shall maintain an index of al drawings and technical memoranda produced in connection with design, fabrication and test of the system. This index shall be updated monthly and copies shall be submitted to the FAA as specified in the contract.

3.12.5 Maintenance Instruction Manuals - The contractor shall provide maintenance instruction manuals of sufficient depth to permit FAA mmaintenance and operation of the equipment. These manuals shall include theory of operation, operating instructions maintenance instructions (including a complete set of block and schematic diagrams), circuit diagrams, parts and test equipment lists and instructions for running and evaluating the results of diagnostic, maintenance and test software. The manuals shal be provided in accordance with FAA-D-2494, as modified by Appendix A,

paragraph 1.3 of FAA-E-2591a. Engineering drawings shall be in accordance with FAA-STD-002, with Amendment 1. Engineering logic diagrams shall be in accordance with FAA-STD-010a.

3.12.6 Progress Reports - The contractor shall provide periodic progress reports as defined and scheduled in the contract.

4. QUALITY ASSURANCE PROVISIONS - The contractor shall establish and maintain a quality control program in accordance with FAA-STD-013a. The quality assurance provisions specified in Section 1-4 of FAA-G-2100/1 form a part of this specification unless otherwise noted. The following levels of inspection and testing are applicable to all systems and shall be conducted in accordance with requirements put forth in the contract.

Records of tests, including examinations and inspections shall be kept complete and available to the Government. All tests and inspections shall be performed by the contractor. The Government, however, reserves the right to witness or perform any of the test or inspections required. The Governement reserves the right to subject all tests and inspections to Government approval by FAA inspectors. The Government also reserves the right to waive the requirements of any portion of the inspections and tests. All tests shall be conducted in accordance with test methods and procedures stated in the Government approved test plan.

The contractor shall be responsible for conducting all required tests. Whenever tesing is scheduled, the contractor shall ascertain that the test scripts and test data sheets have been distributed, and that the test ara has been cleared of all equipment parts, and components, not required for the subject test. All he test personnel shall ncrmally be provided by the contractor. However, the FAA reserves the right to use FAA personnel in lieu cf contractor personnel to man any operating position in the equipment configuration under tes. The contractor shall make any and all additional tests necessary to demonstrate compliance to the required system performance. If duringthe course of any tests, errors or malfunctions occur, the

contractor shall file the appropriate forms and mak entries in the appropriate forms and make entries in the appropriate logs. In addition, the contractor shall document each error or malfunction indicating the type, the procedures taken, the time required to correct and make the error assignment to the appropriate equipment or software element.

The contractor shall be responsible for incorporating and testing any modification to his design found necessary during the testing of the equipments. No design changes or modifications will be allowed to the equipment under test without the approval of the designated FAA representative. If any changes are found to be necessary, the Government reserves the right to required any completed tests to be rerun to verify that no adverse effects result from the change. Failure during testing shall be recorded in accordance with the Facility Outage and Equipment Failure Report (FAA Handbook SM P 6040.1B). Maintenance logs shall utilize FAA Form 6030.1 and be filled out per Order SM 6030.36A. The FAA may require the contractor to repeat tests, or portions thereof, if the original tests fail to demonstrate compliance with the specification.

Two major categories of tests are required: design verification tests which are conducted on selected units, subsystems and systems and acceptance tests which re conducted on all units, subsystems and systems.

4.1 Design Verification Tests - The contractor shall conduct design tests to demonstrate that the requirements of this specification have been met. These tests shall be conducted in the factory or at a government approved test facility or some combination thereof. Design Verification testing shall consist of:

Unit Tests

Subsystem Tests

System Tests

Reliability Tests

Maintainability Tests

Environmental Tests

Type Tests

4.1.1 Unit Tests - The contractor shall conduct unit tests to verify that each individual piece of hardware meets the performance requirements as specified herein and in FAA-E-2591a. These tests shall be conducted on one unit of each hardware type which is new or modified. Unit tests shall include, but not be limited to, first article inspection.

4.1.2 Subsystem Tests - Subsystem tests are tests of equipment combinations and/or equipment and operational software combinations. The contractor shall conduct such tests on those subsystems identified in the contract to verify proper operation of the subsystems and to provide confidence that the system tests will have a high probability of success.

4.1.3 System Tests - The contractor shall conduct system tests to verify that all performance requirements of this specification have been met. These tests shall be designed to exercise the total system consisting of ARTS III equipments currently in operational use, new ARTS IIIA equipments and the operational software. Video inputs (GFE) shall be used. These tests shall be conducted on one single RT & BTL system and one dual RT & BTL system.

As part of this test system response times and capacity shall be measured.

4.1.3.1 Confidence/Stability Test - As part of the system test, a continuous confidence/stability test shall be performed using video inputs with the operational program running. Manual inputs from the display data entry devices shall also be used. Measurements shall be made at the beginning of the test and at specified intervals which shall be indicative of the stability of the system. All system adjustments shall be made prior to the start of the test and no further adjustments will be allowed for the duration of

the test. During the last half-hour of the test, a simulated power failure test shall be made. This test shall be made by interrupting all AC power to the system for a period of at least 15 seconds. When power is restored, all malfunctions or errors shall be recorded. The test shall be resumed without any equipment adjustments. If manual adjustments or intervention is required to re-initiate operation, these shall be fully documented in the test report. The contractor shall include in his draft plan the proposed past/fail criteria to be used in his recommendation on the length of time the test should run (minimum of 72 hours is required).

4.1.4 Reliability Demonstration Testing - The contractor shall perform a reliability demonstration test on all units not previously tested to MIL-STD-781. The test shall be performed using the reliability criteria defined in Section 3 as the basic accept/reject criteria. The reliability demonstration shall be performed in accordance with Test Plan XXV of MIL-STD-781. Preventive maintenance tasks, where required to be accomplished during the reliability demonstration, shall meet the requirements of Setion 3 and Paragrph 4.1.5. These test results shall be used to calculate the dual RT and BTL system reliability performances.

4.1.5 Maintainability Tests

4.1.5.1 Corrective Maintenance Demonstration Tasks - The contractor shall develop corrective maintenance demonstration plans in accordance with MIL-STD-471, except as modified herein. The task selections shall be outlined in Appendix A of MIL-STD-471. The statistical corrective maintenance demonstration tasks shall have failure modes based on information from the Failure Modes and Effects Analysis from Section 3 of this specification. Method 1, Plan A1 of MIL-STD-471 shall be employed by the contractor for corrective maintenance tasks in accordance with the procedure outlined in Appendix A of MIL-STD-471. The Government will randomly select 50 of these tasks for the statistical corrective maintenance demonstration. The mean corrective maintenance downtime shall be less than

the mean corrective maintenance downtime (MTTR) specified in Section 3. During the corrective maintenance demonstration any real equipment failure shall be corrected. Such a failure shall be timed and counted as part of the demonstration.

4.1.5.2 Preventive Maintenance Demonstration Tasks - The contractor shall develop a preventive maintenance plan, including all preventive maintenance tasks and the frequency at which they will be performed. These tasks shall be incorporated as a part of the Maintenance Instruction Manuals. Each preventive maintenance task shall be performed during the preventive maintenance demonstration. The time to perform these tasks shall not exceed that permitted by Section 3.8 of this specification. Equipment required for operation (on-line) use shall not be pre-empted for preventive maintenance, nor shall preventive maintenance be perfcrmed on equipment which is in use in the on-line system. The ability to perform preventive maintenance without degrading system performance shall be demonstrated.

4.1.6 Environmental Tests - The contractor shall conduct environmental tests on all new and modified equipments to verify that these equipments can meet the environmental requirements specified in Sections 3.11.3.11, 3.11.3.11.1, and 3.11.3.11.2 of FAA-TD/S-120-801A (salt atmosphere test is not required).

4.1.7 Type Tests - The contractor shall conduct type tests as specified in Section 1.4.3.3 of FAA-G-2100/1b. At a minimum, these tests shall consist of the environmental tests required in Section 4.1.6.

4.2 Acceptance Tests - The contractor shall conduct acceptance tests on all units, subsystems, and systems that are delivered to the government. Acceptance tests are a combination of factory and site tests.

4.2.1 Factory Tests - Factory tests are those unit and subsystem tests conducted within the contractors plant to ensure that each unit, subsystem, and system meets the requirements of this specification prior to

delivery.

4.2.1.1 Factory Inspection - The quality assurance provisions specified in FAA-G-2100 and MIL-I-45208A form a part of this specification and shall be complied with. All inspections and tests at the contractor's plant shall be performed by the contractor, and may be witnessed, and subject to approval by FAA inspectors. The government reserves the right to waive the requirements of any portion of the inspections and tests.

4.2.1.2 Incoming Inspection - The government may elect to witness incoming inspection of all or any portion of the components and materials used in construction of the equipment to determine compliance with the specifications covering component procurement.

4.2.1.3 Unit Inspection - Each completed unit supplied as an integral part (or spare unit) of each system under the contract shall be given a mechanical and electrical examination. The mechanical examination shall be used to determine compliance with the applicable specifications covering fabrication requirements such as strength and rigidity, accessibility, type of components and materials, choise of insulation, layout of chassis, panel, and wiring, finish and marking. The contractor shall perform an electrical inspection to determine compliance with the applicable specificaticns covering electrical continuity, leakage resistance, power supply voltages and regulation, signal to noise ratio, pulse and wave shapes, resolution, and storage characteristics.

Units built, tested, and approved in accordance with the applicable specifications may be retained temporarily by the contractor in order to facilitate testing of associated units. However, such units used for test purposes shall be given a mechanical and electrical re-inspection prior to government acceptance if required by the contracting officer.

4.2.1.4 Subsystem Tests - Prior to integration into a system, subsystems shall be tested to determine compliance with the functional requirements of

specification. In particular, each disc subsystem (hardware and relevant operational software) which will be integrated into existing ARTS III BTL systems shall be tested as a subsystem prior to delivery; disc subsystems which will be integrated into RT & BTL systems shall be similarly tested prior to factory operational system tests (see Section 4.2.1.5). In addition, all support software shall be functionally tested and be subject to error correction and retesting in the same manner as operational software.

4.2.1.5 Operational System Tests - Each single and dual RT & BTL system shall be functionally tested with the operational software prior to delivery using real or simulated inputs. Wherever possible, compliance with system performance requirements shall be verified. The tests shall be designed to insure a high degree of confidence in the proper operation of the system when installed at the site. Those items of the system needed for these tests, but which are not new or modified (i.e., not deliverable under the contract) shall be supplied as GFE.

4.2.2 Site Tests - The contractor shall conduct site tests for every system installation. Site tests shall be conducted at the unit, the subsystem and the system level consistent with the installation and cutover plan (see Section 3.11). Each site test shall be designed to meet the follcwing objectives:

1. To verify that the installed unit, subsystem or system meets the performance requirements of this specification.

2. To verify that existing ARTS III functions can be performed with the unit, subsystem or system installed.

3. To provide the required certification procedures to enable the FAA to operate with the installed unit subsystem or system.

These tests shall be conducted in three stages in accordance with the government-approved installation plan:

1. Stage 1 - Stage one shall verify system integrity pricr to interfacing with any site equipment. Stage one must be successfully completed before Stage two can be started.

2. Stage 2 - Stage two shall be an integrated test to be conducted after the system is integrated with the site facilities. To minimize interference with the normal operations, this test shall be conducted with the required number of displays in a test bed configuration.

3. Stage 3 - This stage shall use all operational displays to demonstrate complete site adaption. During this test all functions and combinations cf functions such as keyboard and trackball data entry tracking, and display processing, shall be exercised to show conformance with each of the systems operating requirements.

4.3 Test Conduct - The contractor shall be responsible for conducting all tests. Whenever testing is scheduled, the contractor shall ascertain that all necessary personnel are available, that contractor provided procedures, test scripts, and test data sheets have been distributed and that the test area has been cleared of all equipment. All test personnel shall normally be provided by the contractor. However, the FAA reserves the right to use FAA personnel in lieu of contractor personnel to man any operating position in the equipment configuration under test. The contractor shall conduct a test briefing and debriefing for each test and shall assure that all personnel have been properly instructed in their duties. The contractor shall make any and all additional tests necessary to demonstrate compliance to the required system performance. If, during the course of any tests, errors or malfunctions occur, the contractor shall make entries in the appropriate logs. In addition, the contractor shall document each error or malfunction indicating the type, the procedures taken and the time required to circumvent, and the assignment to the appropriate equipment cr software element.

4.3.1 Failure Accountability - There are two major classes of failure: relevant (countable) failures and non-relevant (non-countable) failures.

Relevant failures are defined as:

(a) Manufacturing defects

(b) Parts defects

(c) Design defects

(d) Unknown

Failures due to other causes shall be classified non-relevant. This class includes failures due to:

(a) Accident or mishandling

(b) Operator (where not due to improper design)

(c) Failure of part not supplied by the contractor

(d) Test equipment or facility failure

(e) Installation error

The burden shall be on the contractor to show that a failure should be classified non-relevant.

4.3.1.1 Failure Recording and Reporting - Failures shall be recorded in accordance with the Facility Outage and Equipment Failure Report (FAA Handbook SMP 6040.1B). Maintenance logs shall utilize FAA Form 406C.

4.3.1.2 Additional Tests - The FAA may require the contractor to repeat tests, or portions thereof, if the original tests fail to demonstrate compliance with the specification.

4.3.1.3 Problem Areas - The contractor shall be responsible for solving problems encountered in providing a system to the requirements of this

document. He shall notify the FAA promptly of any problems beyond his jurisdiction.

4.3.1.4 Equipment Module or Subsystem Modification - The ccntractor shall be responsible for incorporating and testing any modifications to the design necessary to meet specification requirements. Resulting modificaticns to equipment shall be inccrporated into each system delivered at no additional cost to the Government.

4.3.1.5 Documentation Updating - The ccntractor shall update the system documentation of block diagrams, electrical and mechanical drawings, installation drawings, part lists, wire lists, logic flow charts and diagrams, computer programs and flow charts, and all associated descriptive materials. The updating shall be accomplished periodically to maintain the above described documentation in current status. Updated drawings shall be prepared in accordance with the drawing standards specified in Graphic Symbols for Digital Diagrams (FAA-STD-010). All copies of obsolete and voided documents shall be so marked and disposition shall be made in accordance with FAA instructions.

5. PREPARATION FOR SHIPMENT - All equipment and spares shall be prepared for shipment and shipped in accordance with MIL- E -17555 Method 3 unless air ride padded shipment is used. Shipment shall be in accordance with the contract requirements.

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DPS	Data Processing Subsystem
ESR	Executive Service Request
FDB	Full Data Block
FP	Flight Plan
GFE	Government Furnished Equipment
Hz	Hertz
ICA	Interfacility Communication Adapter
ID	Identification
IMT	Integral Magnetic Tape
I/O	Input/Output
IOP	Input Output Processor
LDB	Limited Data Block
MHz	Mega Hertz
MM	Memory Module
MSP	Medium Speed Printer
MSS	Mass Storage Subsystem
MTI	Moving Target Indicator
MTTR	Mean-Time-to-Repair
NDRO	Non Destructive Read Out
NM	Nautical Mile
NSP	Non Standard Part
PFA	Probability of False Alarm
PN	Probability of Noise

PRF	Pulse Repitition Frequency
PSM	Peripheral Switch Module (PSM)
RDAS	Radar Data Acquisition Subsystem
RFDU	Reconfiguraticn and Fault Detection Unit (RFDU)
RML	Radar Microwave Link
RSL	Recovery System Library
RT&BTL	Radar Tracking and Beacon Tracking Level
RIP	Radar Input Processing
RTQC	Real Time Quality Control
SP	Site Parameter
SPI	Special Position Indicator
TL	Target Lead Edge
TOS	Track Oriented Smoothing
TRACON	Terminal Radar Control

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